

**A RADIO TEST REPORT**  
**FOR**  
**ROTORK CONTROLS LTD**  
**ON**  
**PAKSCAN 3 WIRELESS FIELD CONTROL UNIT**  
**DOCUMENT NO. TTR-005152-00-W-US-01**

**HULL**

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**TRaC Wireless Test Report** : TTR-005152-00-W-US-01

**Applicant** : Rotork Controls Ltd

**Apparatus** : Pakscan 3 Wireless Field Control Unit

**Specification(s)** : CFR47 Part 15.247 November 2011

**FCCID** : ZK4P3W-001

**Purpose of Test** : **Certification**

**Authorised by**

: 

: Radio Product Manager

**Issue Date** : 24<sup>th</sup> February 2012

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**Section 1:****Introduction****1.1 General**

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on samples submitted to the Laboratory.

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## **1.2 Tests Requested By**

This testing in this report was requested by :

Rotork Controls Ltd  
Brassmill Lane  
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BA1 3JQ

## **1.3 Manufacturer**

As Above

## **1.4 Apparatus Assessed**

The following apparatus was assessed between 9<sup>th</sup> – 14<sup>th</sup> February 2012:

Pakscan 3 Wireless Field Control Unit

The Pakscan 3 Wireless Field Control Unit is a digital spread spectrum device operating the 2.4 GHz band.

## 1.5 Test Result Summary

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

The statements relating to compliance with the standards below apply ONLY as qualified in the notes and deviations stated in sections 1.6 to 1.7 of this test report.

Full details of test results are contained within Appendix A. The following table summarises the results of the assessment.

Test Type	Regulation	Measurement standard	Result
Radiated spurious emissions (Restricted bands)	Title 47 of the CFR: Part 15 Subpart C; 15.247	ANSI C63.10:2009	Pass
Conducted spurious emissions (Non-restricted bands)	Title 47 of the CFR: Part 15 Subpart C; 15.247	ANSI C63.10:2009	Pass
AC Power conducted emissions	Title 47 of the CFR: Part 15 Subpart C; 15.207	ANSI C63.10:2009	N/A Note 1
Occupied Bandwidth	Title 47 of the CFR : Part 15 Subpart C; 15.247(a)(2)	ANSI C63.10:2009	Pass
Conducted Carrier Power	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)	ANSI C63.10:2009	Pass
Power Spectral Density	Title 47 of the CFR : Part 15 Subpart C; 15.247(d)	ANSI C63.10:2009	Pass
Unintentional Radiated Spurious Emissions	Title 47 of the CFR: Part 15 Subpart B; 15.109	ANSI C63.10:2009	Pass
Digital Modulation	Title 47 of the CFR: Part 15 Subpart C; 15.403	-	Pass
RF Safety	Title 47 of the CFR : Part 15 Subpart C; 15.247(b)(5)	-	Pass

Note 1: The EUT is powered by +24Vdc

Abbreviations used in the above table:

ANSI C 63.10:2009 is outside the scope of the laboratories UKAS accreditation.

Mod	: Modification	ANSI	: American National Standards Institution
CFR	: Code of Federal Regulations	PLCE	: Power Line Conducted Emissions
REFE	: Radiated Electric Field Emissions		

## **1.6 Notes Relating To The Assessment**

With regard to this assessment, the following points should be noted:

The results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 1.7 of this test report (Deviations from Test Standards).

For emissions testing, throughout this test report, "Pass" indicates that the results for the sample as tested were below the specified limit (refer also to Section 2, Measurement Uncertainty).

Where relevant, the apparatus was only assessed using the monitoring methods and susceptibility criteria defined in this report.

All testing with the exception of testing at the Open Area Test Site was performed under the following environmental conditions:

Temperature	: 17 to 23 °C
Humidity	: 45 to 75 %
Barometric Pressure	: 86 to 106 kPa

All dates used in this report are in the format dd/mm/yy.

This assessment has been performed in accordance with the requirements of ISO/IEC 17025.

## **1.7 Deviations from Test Standards**

There were no deviations from the standards tested to.

## Section 2:

## Measurement Uncertainty

### 2.1 Measurement Uncertainty Values

For the test data recorded in accordance with note (iii) of Section 2.1 the following measurement uncertainty was calculated:

#### Radio Testing – General Uncertainty Schedule

*All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence where no required test level exists.*

##### **[1] Adjacent Channel Power**

Uncertainty in test result = **1.86dB**

##### **[2] Carrier Power**

Uncertainty in test result (Power Meter) = **1.08dB**

Uncertainty in test result (Spectrum Analyser) = **2.48dB**

##### **[3] Effective Radiated Power**

Uncertainty in test result = **4.71dB**

##### **[4] Spurious Emissions**

Uncertainty in test result = **4.75dB**

##### **[5] Maximum frequency error**

Uncertainty in test result (Power Meter) = **0.113ppm**

Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

##### **[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field**

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,

Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,

Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

##### **[7] Frequency deviation**

Uncertainty in test result = **3.2%**

##### **[8] Magnetic Field Emissions**

Uncertainty in test result = **2.3dB**

##### **[9] Conducted Spurious**

Uncertainty in test result – Up to 8.1GHz = **3.31dB**

Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**

Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**

Uncertainty in test result – Up to 26GHz = **3.14dB**

##### **[10] Channel Bandwidth**

Uncertainty in test result = **15.5%**



**[11] Amplitude and Time Measurement – Oscilloscope**

Uncertainty in overall test level = **2.1dB**,  
Uncertainty in time measurement = **0.59%**,  
Uncertainty in Amplitude measurement = **0.82%**

**[12] Power Line Conduction**

Uncertainty in test result = **3.4dB**

**[13] Spectrum Mask Measurements**

Uncertainty in test result = **2.59% (frequency)**  
Uncertainty in test result = **1.32dB (amplitude)**

**[14] Adjacent Sub Band Selectivity**

Uncertainty in test result = **1.24dB**

**[15] Receiver Blocking – Listen Mode, Radiated**

Uncertainty in test result = **3.42dB**

**[16] Receiver Blocking – Talk Mode, Radiated**

Uncertainty in test result = **3.36dB**

**[17] Receiver Blocking – Talk Mode, Conducted**

Uncertainty in test result = **1.24dB**

**[18] Receiver Threshold**

Uncertainty in test result = **3.23dB**

**[19] Transmission Time Measurement**

Uncertainty in test result = **7.98%**

## **Section 3:**

## **Modifications**

### **3.1 Modifications Performed During Assessment**

No modifications were performed during the assessment

**Appendix A:****Formal Emission Test Results**

Abbreviations used in the tables in this appendix:

Spec	: Specification	ALSR	: Absorber Lined Screened Room
Mod	: Modification	OATS	: Open Area Test Site
		ATS	: Alternative Test Site
EUT	: Equipment Under Test		
SE	: Support Equipment	Ref	: Reference
		Freq	: Frequency
L	: Live Power Line		
N	: Neutral Power Line	MD	: Measurement Distance
E	: Earth Power Line	SD	: Spec Distance
Pk	: Peak Detector	Pol	: Polarisation
QP	: Quasi-Peak Detector	H	: Horizontal Polarisation
Av	: Average Detector	V	: Vertical Polarisation
CDN	: Coupling & decoupling network		

**A1 6 dB Bandwidth**

Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(2) requires the measurement of the bandwidth of the transmission between the -6 dB points on the transmitted spectrum.

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) 15.247(a)(2)
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	TRLUH100
Temperature	21°C
EUT set up	Refer to Appendix C

Channel Frequency (MHz)	F <sub>lower</sub>	F <sub>Higher</sub>	Measured 6 dB Bandwidth (kHz)	Limit	Result
2405.0 MHz	2404.294872	2405.897436	1602.546	>500kHz	Pass
2435.0 MHz	2434.294872	2435.897436	1602.564	>500kHz	Pass
2465.0 MHz	2464.278045	2465.896635	1618.589	>500kHz	Pass

Plots of the 6 dB bandwidth are contained in Appendix B of this test report.

**A2 Transmitter Peak Output Power**

Carrier power was verified with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

<b>Test Details:</b>	
Regulation	Title 47 of the CFR: Part15 Subpart (c) 15.247(b)(3)
Measurement standard	ANSI C63.10
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	TRLUH100
EUT set up	Refer to Appendix C
Temperature	21°C

<b>Channel Frequency (MHz)</b>	<b>Conducted Peak Carrier Power (dBm)</b>	<b>Conducted Peak Carrier Power (W)</b>	<b>Limit (W)</b>	<b>Result</b>
2405.0 MHz	14.8	0.0304	1	Pass
2435.0 MHz	15.2	0.0332	1	Pass
2465.0 MHz	15.5	0.0356	1	Pass

Notes:

**Conducted Measurement**

Conducted measurements were performed with an antenna connector provided by the client. See Annex B for plots.  
Plots in annex B do not include losses between EUT and measurement device.  
Losses between EUT and measurement device are 20 dB.

**A3 Transmitter Power Spectral Density**

Transmitter Power Spectral Density was verified with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

<b>Test Details:</b>	
Regulation	Title 47 of the CFR: Part15 Subpart (c) 15.247(e)
Measurement standard	ANSI C63.10
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	TRLUH100
EUT set up	Refer to Appendix C
Temperature	21°C

<b>Channel Frequency (MHz)</b>	<b>Conducted Peak Power Spectral Density (dBm/3kHz)</b>	<b>Limit (dBm/3kHz)</b>	<b>Result</b>
2405.0 MHz	0.5	+8	Pass
2435.0 MHz	0.8	+8	Pass
2465.0 MHz	0.8	+8	Pass

Notes:

**Conducted Measurement**

Conducted measurements were performed with an antenna connector provided by the client.  
The resolution bandwidth on the analyser was set to 3kHz and trace set to max hold.

The span is set to 3MHz

The sweep time is 1000 seconds (Span/3kHz).

See Annex B for plots.

Plots in annex B include losses of 20 dB between EUT and measurement device.

**A4 RF Antenna Conducted Spurious Emissions**

Measurement of conducted spurious emissions at the antenna port was performed using a peak detector with the RBW set to 100kHz and the VBW>RBW. Frequencies were scanned up through to the 10th harmonic with the EUT transmitting on its lowest, centre and highest carrier frequency in turn.

<b>Test Details:</b>	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10
Frequency range	9 kHz to 25 GHz
EUT sample number	S01
Modification state	0
SE in test environment	None
SE isolated from EUT	TRLUH100
EUT set up	Refer to Appendix C
Temperature	21°C

The worst case conducted emission measurements at the antenna port are listed below:

**Channel 11 - 2405.0 MHz**

Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1.	No Significant Emissions within 20 dB of the limit					

**Channel 17 - 2435.0 MHz**

Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1.	No Significant Emissions within 20 dB of the limit					

**Channel 23 - 2465.0 MHz**

Ref No.	Measured Freq (MHz)	Det.	Is measured Frequency within the Restricted bands (Y/N)	Measured Peak Conducted power (RBW =100kHz) (dBuV)	15.247(d) Limit (dBuV)	Summary
1.	No Significant Emissions within 20 dB of the limit					

**Notes:**

1. The conducted emission limit for emissions outside the restricted bands, defined in 47CFR15.205(a) are based on a transmitted carrier level of 15.247(b). With the EUT transmitting on its lowest, centre and highest carrier frequencies in turn, emissions from the EUT are required to be 20 dB below the level of the highest fundamental as measured within a 100 kHz RBW in accordance with 15.247(d) using a peak detector.
2. The RBW = 100 kHz, Video bandwidth (VBW) > RBW and the radio spectrum was investigated up to the 10th harmonic in accordance 15.33 (a)(1).
3. The measurements at 2400 MHz and 2483.5 MHz were made to ensure band edge compliance. See plots in annex B.
4. The carrier level was measured whilst varying the supply voltage between 85% and 105% of the nominal supply voltage as required by 15.31(e). No variation in carrier level was observed. All other emissions were at least 20dB below the test limit

The limit outside the restricted band in 100 kHz RBW is defined using the following formula in accordance with 15.247(d):

$$\text{The limit in 100 kHz RBW} = (\text{Maximum Peak Conducted Carrier}) - 20\text{dB}$$

Where:

The maximum peak conducted power was measured using a peak power meter. Please refer to section A1 of this test report.

Channel No.	Channel Frequency (MHz)	Measured Peak Carrier Power (W)	Measured Peak Carrier (dBμV)	Measured Peak Carrier -20dB (dBμV)	Emission Limit In a 100 kHz RBW (dBμV)
11	2405.0 MHz	0.0304	121.8	101.8	101.8
17	2435.0 MHz	0.0332	122.2	102.2	102.2
23	2465.0 MHz	0.0356	122.5	102.5	102.5



**A5 Radiated Electric Field Emissions within the Restricted Bands of 15.205**

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The radiated electric field emission test applies to spurious emissions and harmonics that fall within the restricted bands listed in Section 15.205. The maximum permitted field strength is listed in Section 15.209. The EUT was set to transmit on its lowest, centre and highest carrier frequency.

The following test site was used for final measurements as specified by the standard tested to:

3m open area test site : ☐

3m alternative test site : ☒

The effect of the EUT set-up on the measurements is summarised in note (c) below.

Test Details: 2405.0 MHz	
Regulation	Title 47 of the CFR, Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10
Frequency range	30MHz – 25GHz
EUT sample number	S01 & S02
Modification state	0
SE in test environment	None
SE isolated from EUT	TRLUH100
EUT set up	Refer to Appendix C
Temperature	19°C
Photographs (Appendix F)	1 & 2

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

Ref No.	Pk / Av	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	Pk	4810	65.75	3.7	32.6	35.7	67.05	-	2251.64	5011
2.	Av	4810	44.94	3.7	32.6	35.7	45.54	-	189.23	500

Average levels calculated based on the duty cycle of 8.4 % per 100ms period as declared by the customer (see annex D for declaration).  
See notes section for calculation.

**Radiated Electric Field Emissions within the Restricted Band 15.205 continued:**

The effect of the EUT set-up on the measurements is summarised in note (c) below.

<b>Test Details: 2435.0 MHz</b>	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10:2003
Frequency range	30MHz to 25 GHz
EUT sample number	S01 & S02
Modification state	0
SE in test environment	None
SE isolated from EUT	TRLUH100
EUT set up	Refer to Appendix C
Temperature	19°C
Photographs (Appendix F)	1 & 2

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

Ref No.	Pk / Av	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	Pk	4810	65.75	3.7	32.6	35.7	67.05	-	2251.64	5011
2.	Av	4810	44.94	3.7	32.6	35.7	45.54	-	189.23	500

Average levels calculated based on the duty cycle of 8.4 % per 100ms period as declared by the customer (see annex D for declaration).  
See notes section for calculation.

**Radiated Electric Field Emissions within the Restricted Band 15.205 continued:**

The effect of the EUT set-up on the measurements is summarised in note (c) below.

<b>Test Details: 2465.0 MHz</b>	
Regulation	Title 47 of the CFR: Part 15 Subpart (c) Clause 15.247(d) and Clause 15.205
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S01 & S02
Modification state	0
SE in test environment	None
SE isolated from EUT	TRLUH100
EUT set up	Refer to Appendix C
Temperature	19°C
Photographs (Appendix F)	1 & 2

The worst case radiated emission measurements for spurious emissions and harmonics that fall within the restricted bands are listed below:

Ref No.	Pk / Av	FREQ. (MHz)	MEAS Rx (dBµV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBµV/m)	EXTRAP FACT (dB)	FIELD ST'GH (µV/m)	LIMIT (µV/m)
1.	Pk	2483.5	25.51	2.0	28.4	-	55.91	-	624.45	5011
2.	Av	2483.5	3.99	2.0	28.4	-	34.40	-	52.48	500
3.	Pk	2497.43	68.67	2.0	28.5	35.6	63.57	-	1508.34	5011
4.	Av	2497.43	47.16	2.0	28.5	35.6	42.06	-	126.77	500
5.	Pk	2513.02	62.47	2.1	28.5	35.6	57.47	-	747.31	5011
6.	Av	2513.02	40.96	2.1	28.5	35.6	35.96	-	62.81	500
7.	Pk	2528.8	58.97	2.1	28.6	35.6	54.07	-	505.24	5011
8.	Av	2528.8	37.46	2.1	28.6	35.6	32.56	-	42.46	500
9.	Pk	4810	65.75	3.7	32.6	35.7	67.05	-	2251.64	5011
10.	Av	4810	44.94	3.7	32.6	35.7	45.54	-	189.23	500

Average levels calculated based on the duty cycle of 8.4 % per 100ms period as declared by the customer (see annex D for declaration).

See notes section for calculation.

Emissions at 2483.5 MHz made using delta marker method as defined in ANSI C63.10

**Notes:**

- 1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1
- 2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
- 3 Measurements at 2400 & 2483.5 MHz were made to ensure band edge compliance.
- 4 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
- 5 For Frequencies below 1 GHz, RBW= 100 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:  
     Peak               RBW=VBW= 1MHz  
     Average         RBW=VBW= 1MHz

These settings as per ANSI C63.10

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15 Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits (47 CFR Part 15: Clause 15.209) for emissions falling within the restricted bands defined in 15.205(a):

Frequency of emission (MHz)	Field strength $\mu\text{V/m}$	Measurement Distance m	Field strength $\text{dB}\mu\text{V/m}$
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz)
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

**Duty cycle correction for determining average levels is calculated as follows:**

As per 15.35(c) duty cycle and ANSI C63.10 Section 7.5 duty cycle correction can be calculated as follows.

$$\text{Correction} = 20 \text{ Log } (T_{\text{on}}/100\text{ms})$$

Based on a duty cycle of 8.4% of a 100ms period (Manufacturer Declared)

The peak to average correction is determined by

$$\text{Correction} = 20 \text{ Log } (8.4/100)$$

$$\text{Correction} = -21.51 \text{ dB}$$

**Notes:**

- (a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation (dB)} = 20 \log_{10} \left( \frac{\text{measurement distance}}{\text{specification distance}} \right)$$

The results displayed take into account applicable antenna factors and cable losses.

- (b) The levels may have been rounded for display purposes.
- (c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓			
Effect of EUT internal configuration on emission levels	✓			
Effect of Position of EUT cables & samples on emission levels			✓	
(i) Parameter defined by standard and / or single possible, refer to Appendix D (ii) Parameter defined by client and / or single possible, refer to Appendix D (iii) Parameter had a negligible effect on emission levels, refer to Appendix D (iv) Worst case determined by initial measurement, refer to Appendix D				

## **A7    Antenna Gain**

The maximum antenna gain for the antenna types to be used with the EUT, as declared by the client, is 0 dBi.

**A8 Unintentional Radiated Electric Field Emissions - 15.109**

Preliminary scans were performed using a peak detector with the RBW = 100kHz. The maximum permitted field strength is listed in Section 15.109. The EUT was set to receive mode only on its lowest, centre and highest carrier frequency in turn.

The following test site was used for final measurements as specified by the standard tested to :

3m open area test site : ☐

3m alternative test site : ☒

Test Details:	
Regulation	Title 47 of the CFR: Part 15 Subpart (b) Clause 15.109
Measurement standard	ANSI C63.10
Frequency range	30MHz to 25 GHz
EUT sample number	S01 & S02
Modification state	0
SE in test environment	None
SE isolated from EUT	TRLUH100
EUT set up	Refer to Appendix C
Temperature	19°C
Photographs (Appendix F)	1 & 2

The worst case radiated emission measurements for spurious emissions:

**Channel 11- 2405 MHz**

Ref No.	FREQ. (MHz)	MEAS Rx (dBμV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBμV/m)	EXTRAP FACT (dB)	FIELD ST'GH (μV/m)	LIMIT (μV/m)
1.	No Significant Emissions Within 20 dB of the limit								

**Channel 17- 2435 MHz**

Ref No.	FREQ. (MHz)	MEAS Rx (dBμV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBμV/m)	EXTRAP FACT (dB)	FIELD ST'GH (μV/m)	LIMIT (μV/m)
1.	No Significant Emissions Within 20 dB of the limit								

**Channel 23- 2465 MHz**

Ref No.	FREQ. (MHz)	MEAS Rx (dBμV)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	FIELD ST'GH (dBμV/m)	EXTRAP FACT (dB)	FIELD ST'GH (μV/m)	LIMIT (μV/m)
1.	No Significant Emissions Within 20 dB of the limit								

**Notes:**

- 1 Any testing performed below 30 MHz was performed using a magnetic loop antenna in accordance with ANSI C63.10: section 4.5, Table 1 For emissions below 30MHz the cable losses are assumed to be negligible.
- 2 In accordance with 15.35(b), above 1 GHz, emissions measured using a peak detector shall not exceed a level 20 dB above the average limit.
- 3 Testing was performed with the EUT orientated in three orthogonal planes and the maximum emissions level recorded. In addition, the EUT antenna was varied within its range of motion in order to maximise emissions.
- 4 For Frequencies below 1 GHz, RBW = 120 kHz, testing was performed with CISPR16 compliant test receiver with QP detector. Above 1 GHz tests were performed using a spectrum analyser using the following settings:

Peak	RBW=VBW= 1MHz
Average	RBW=VBW= 1MHz

The upper and lower frequency of the measurement range was decided according to 47 CFR Part 15 Clause 15.33(a) and 15.33(a)(1).

Radiated emission limits 47 CFR Part 15: Clause 15.109 for all emissions:

Frequency of emission (MHz)	Field strength $\mu\text{V/m}$	Measurement Distance m	Field strength $\text{dB}\mu\text{V/m}$
0.009-0.490	2400/F(kHz)	300	67.6/F (kHz)
0.490-1.705	24000/F(kHz)	30	87.6/F (kHz)
1.705-30	30	30	29.5
30-88	100	3	40.0
88-216	150	3	43.5
216-960	200	3	46.0
Above 960	500	3	54.0

- (a) Where results have been measured at one distance, and a signal level displayed at another, the results have been extrapolated using the following formula:

$$\text{Extrapolation (dB)} = 20 \log_{10} \left( \frac{\text{measurement distance}}{\text{specification distance}} \right)$$

- (b) The levels may have been rounded for display purposes.
- (c) The following table summarises the effect of the EUT operating mode, internal configuration and arrangement of cables / samples on the measured emission levels :

	See (i)	See (ii)	See (iii)	See (iv)
Effect of EUT operating mode on emission levels	✓	✓	✓	✓
Effect of EUT internal configuration on emission levels	✓	✓	✓	✓
Effect of Position of EUT cables & samples on emission levels	✓	✓	✓	✓
(i) Parameter defined by standard and / or single possible, refer to Appendix D (ii) Parameter defined by client and / or single possible, refer to Appendix D (iii) Parameter had a negligible effect on emission levels, refer to Appendix D (iv) Worst case determined by initial measurement, refer to Appendix D				

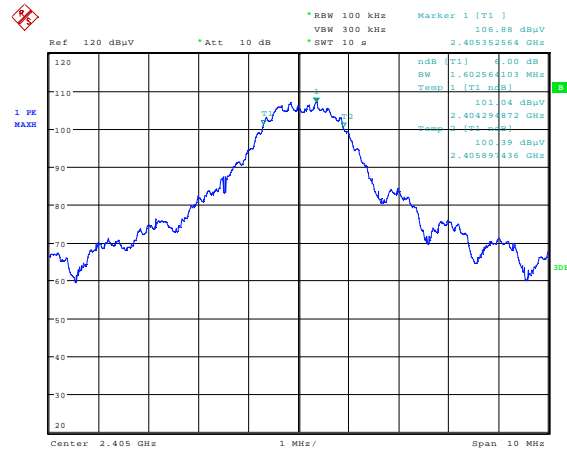


**Appendix B:****Supporting Graphical Data**

This appendix contains graphical data obtained during testing.

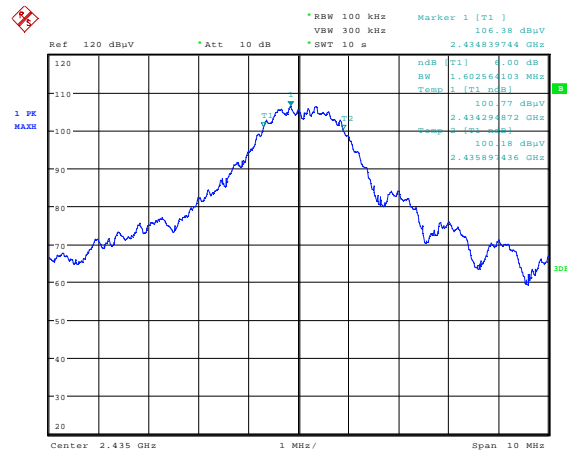
Notes:

- (a) The radiated electric field emissions and conducted emissions graphical data in this appendix is preview data. For details of formal results, refer to Appendix A and Appendix B.
- (b) The time and date on the plots do not necessarily equate to the time of the test.
- (c) Where relevant, on power line conducted emission plots, the limit displayed is the average limit, which is stricter than the quasi peak limit.
- (d) Appendix C details the numbering system used to identify the sample and its modification state.
- (e) The plots presented in this appendix may not be a complete record of the measurements performed, but are a representative sample, relative to the final assessment.



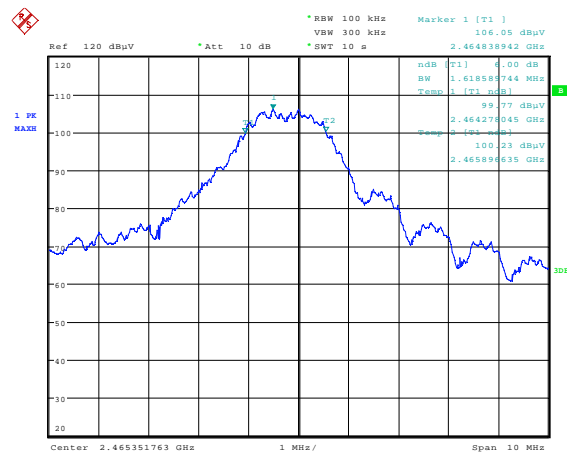
Date: 10.FEB.2012 16:15:00

### 6dB Bandwidth – Channel 11



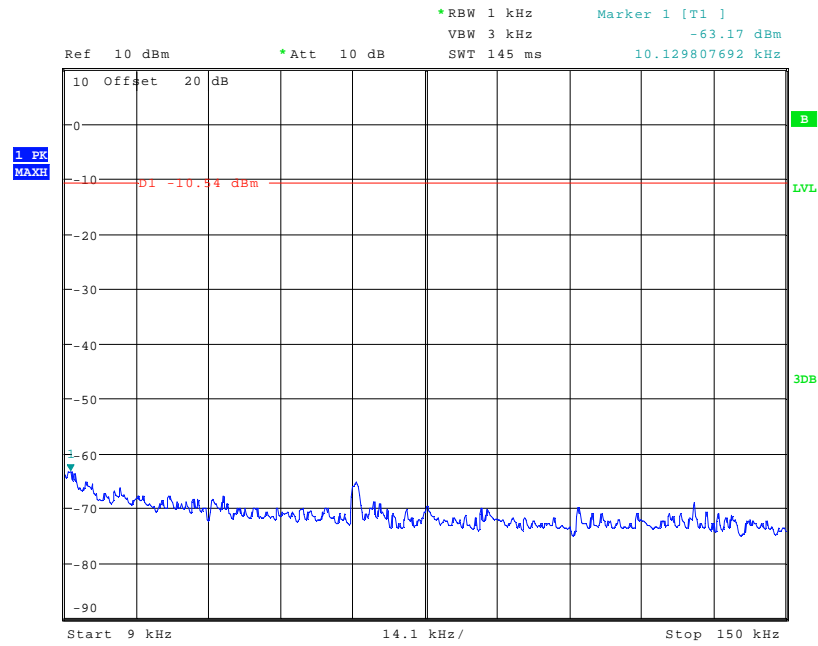
Date: 10.FEB.2012 16:14:01

### 6dB Bandwidth – Channel 17



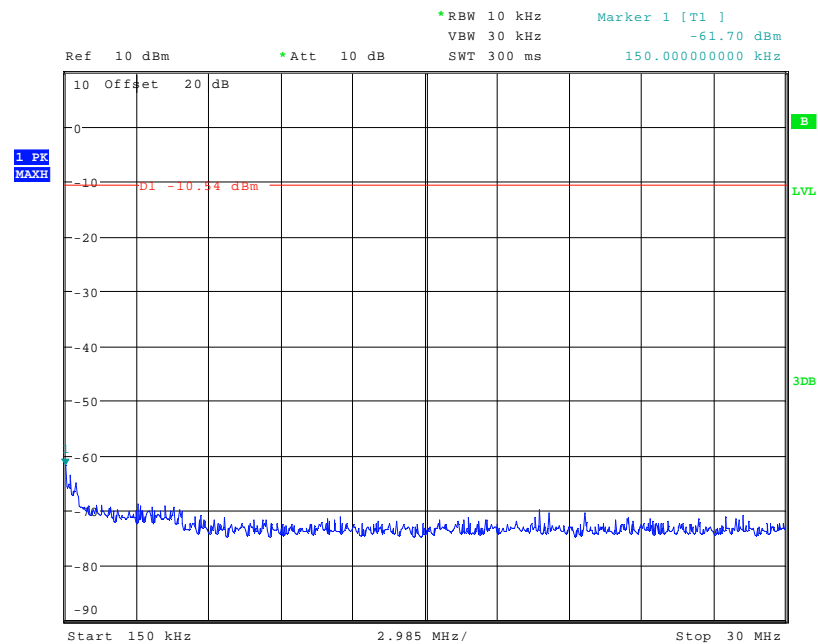
Date: 10.FEB.2012 16:12:18

### 6dB Bandwidth – Channel 23



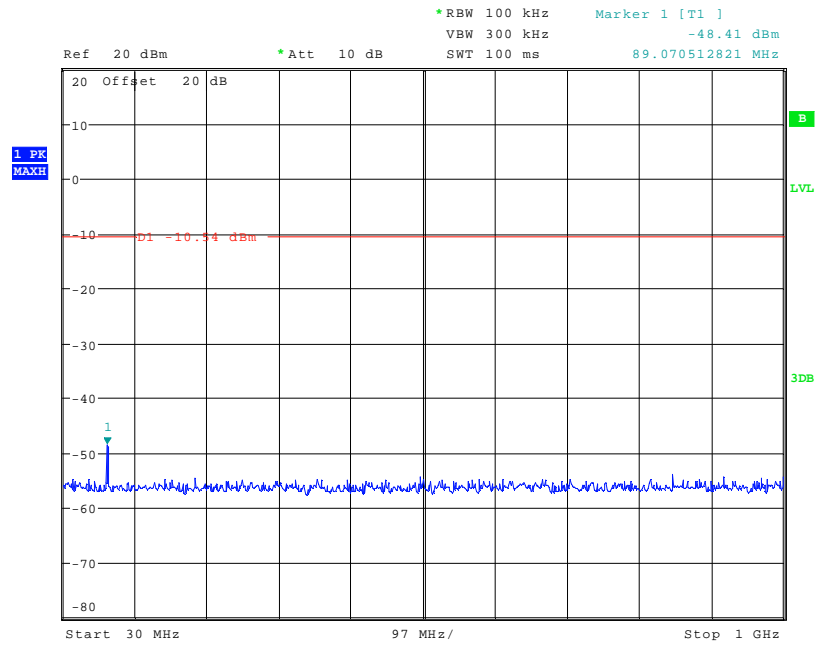
Date: 14.FEB.2012 14:09:48

### Conducted Spurious emissions 9kHz to 150 kHz – 2405.0 MHz



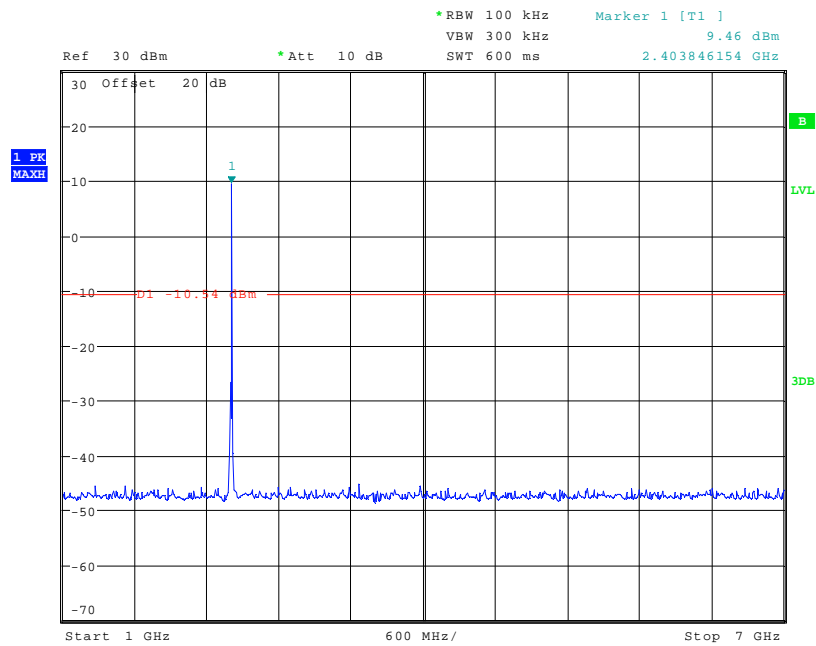
Date: 14.FEB.2012 14:10:23

### Conducted Spurious emissions 150kHz to 30 MHz – 2405.0 MHz



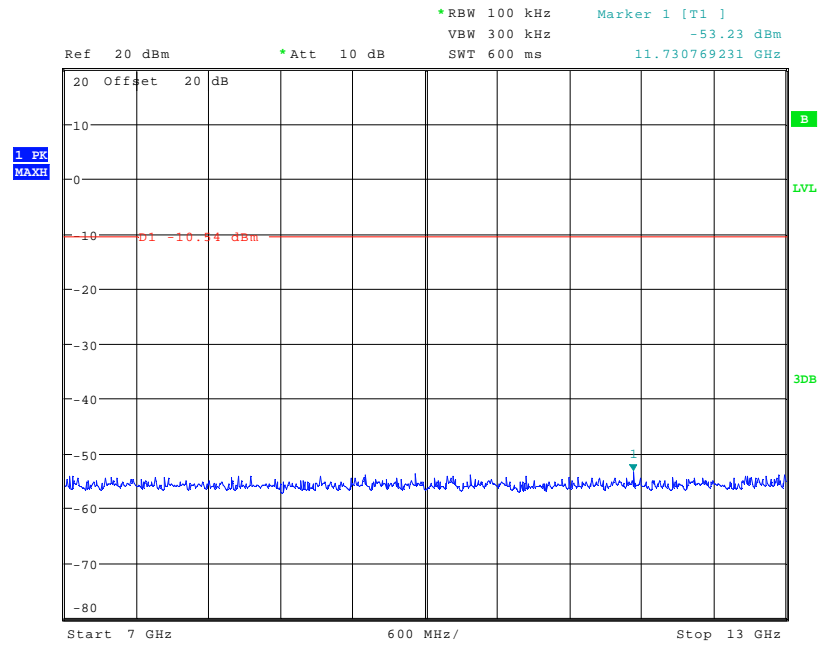
Date: 14.FEB.2012 14:10:51

### Conducted Spurious emissions 30 MHz to 1 GHz – 2405.0 MHz



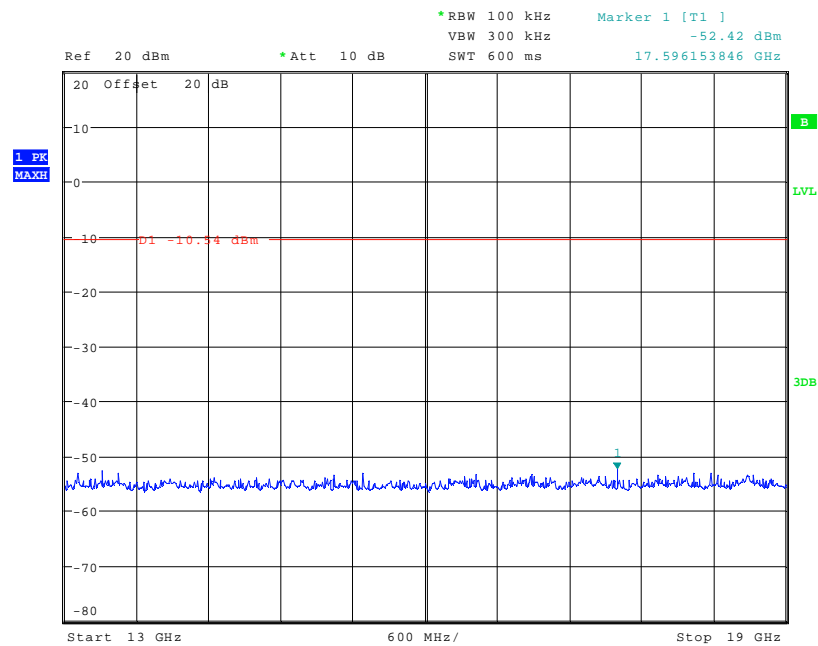
Date: 14.FEB.2012 14:09:02

### Conducted Spurious emissions 1 GHz to 7 GHz – 2405.0 MHz



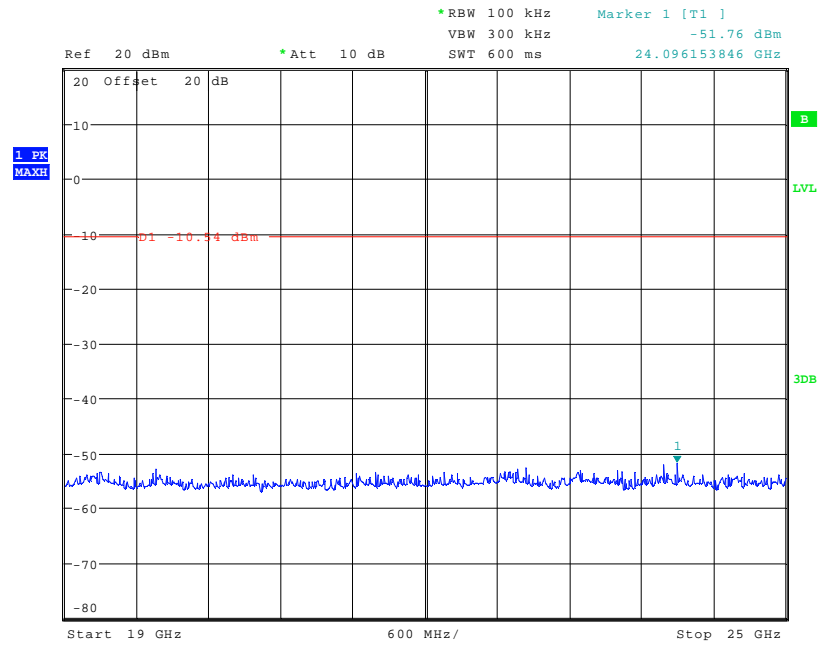
Date: 14.FEB.2012 14:11:16

### Conducted Spurious emissions 7 GHz to 13 GHz – 2405.0 MHz



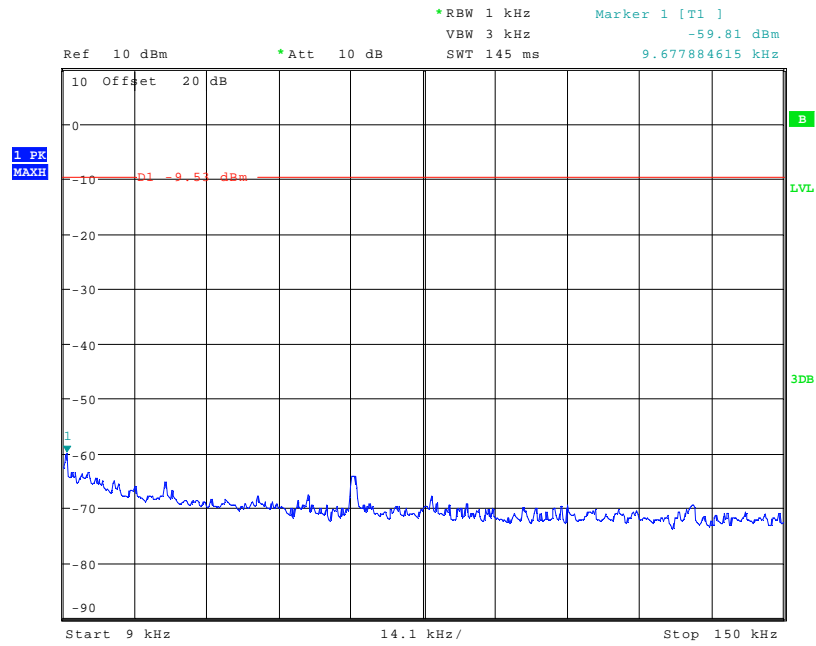
Date: 14.FEB.2012 14:11:59

### Conducted Spurious emissions 13 GHz to 19 GHz – 2405.0 MHz



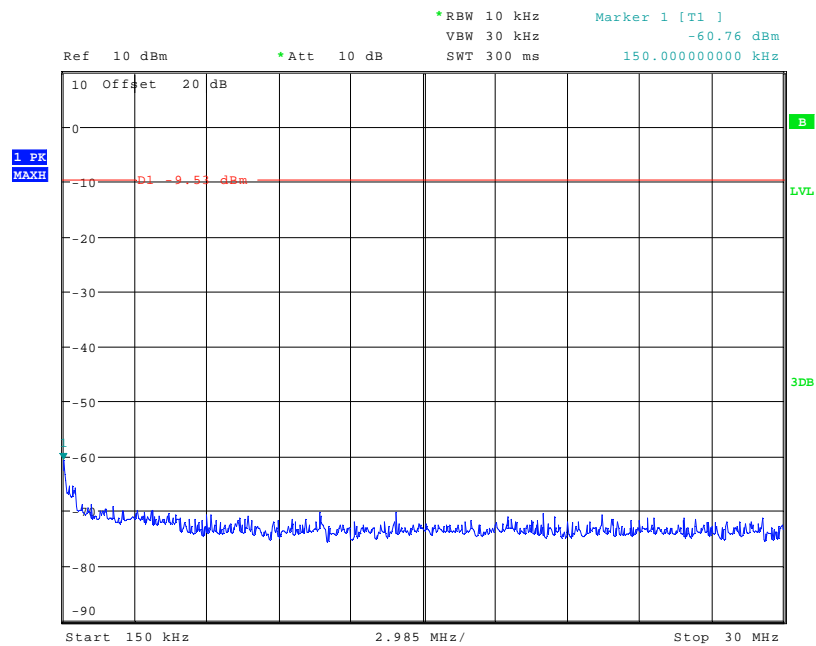
Date: 14.FEB.2012 14:12:19

Conducted Spurious emissions 19 GHz to 25 GHz – 2405.0 MHz



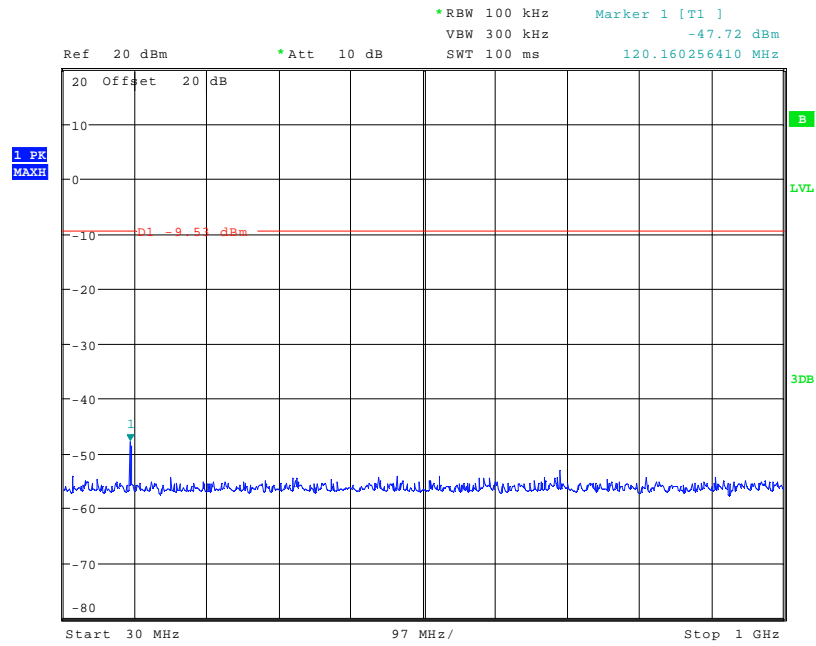
Date: 14.FEB.2012 14:02:12

### Conducted Spurious emissions 9kHz to 150 kHz – 2435.0 MHz



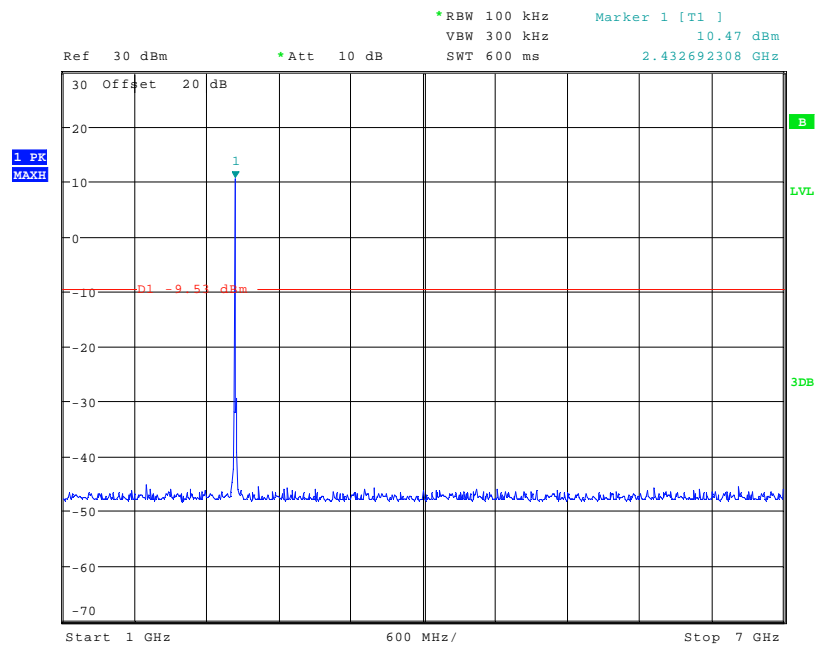
Date: 14.FEB.2012 14:02:38

### Conducted Spurious emissions 150kHz to 30 MHz – 2435.0 MHz



Date: 14.FEB.2012 14:03:04

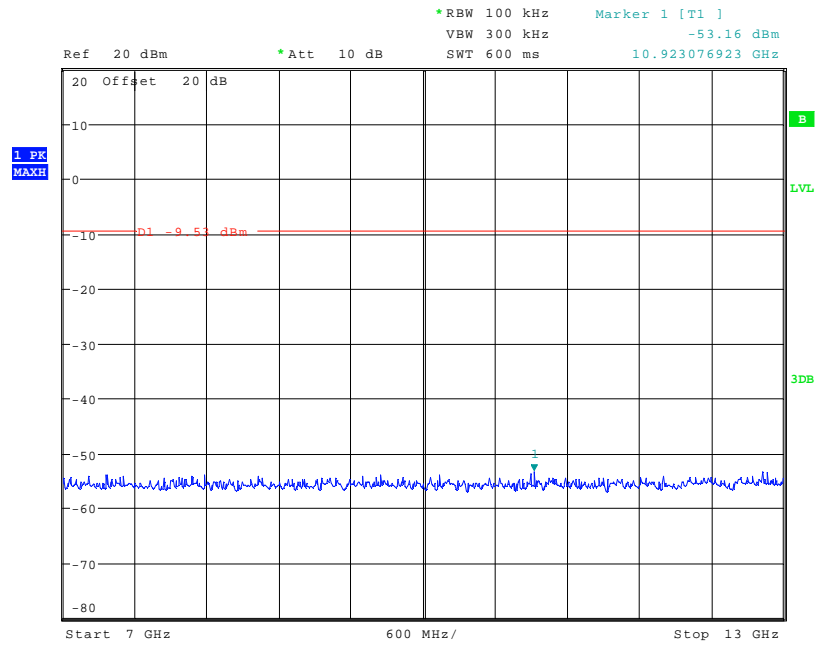
### Conducted Spurious emissions 30 MHz to 1 GHz – 2435.0 MHz



Date: 14.FEB.2012 14:00:23

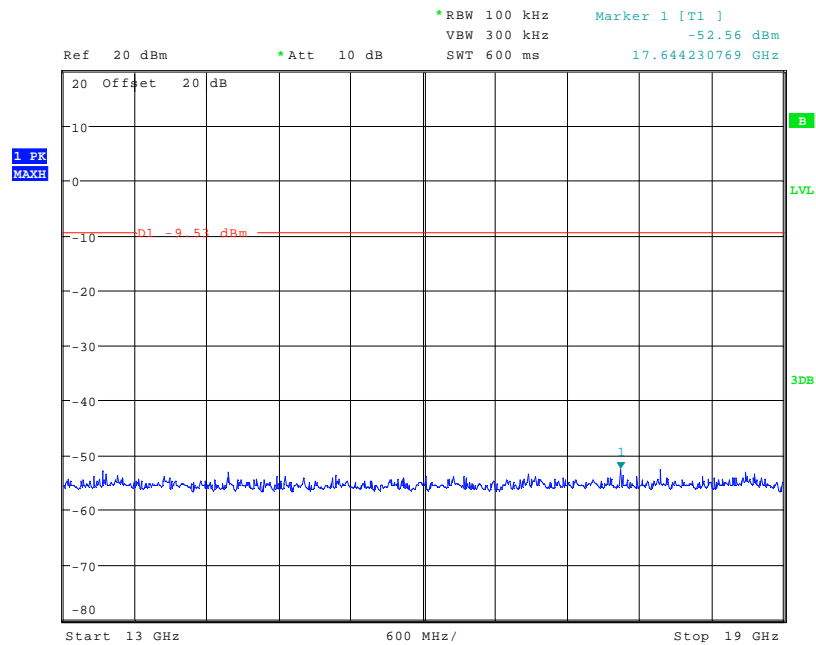
### Conducted Spurious emissions 1 GHz to 7 GHz – 2435.0 MHz





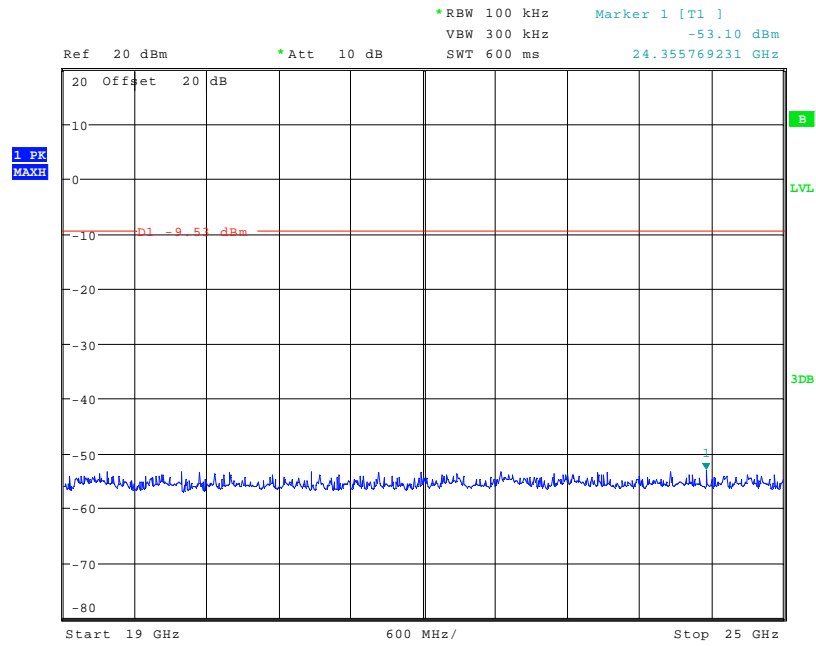
Date: 14.FEB.2012 14:03:34

### Conducted Spurious emissions 7 GHz to 13 GHz – 2435.0 MHz



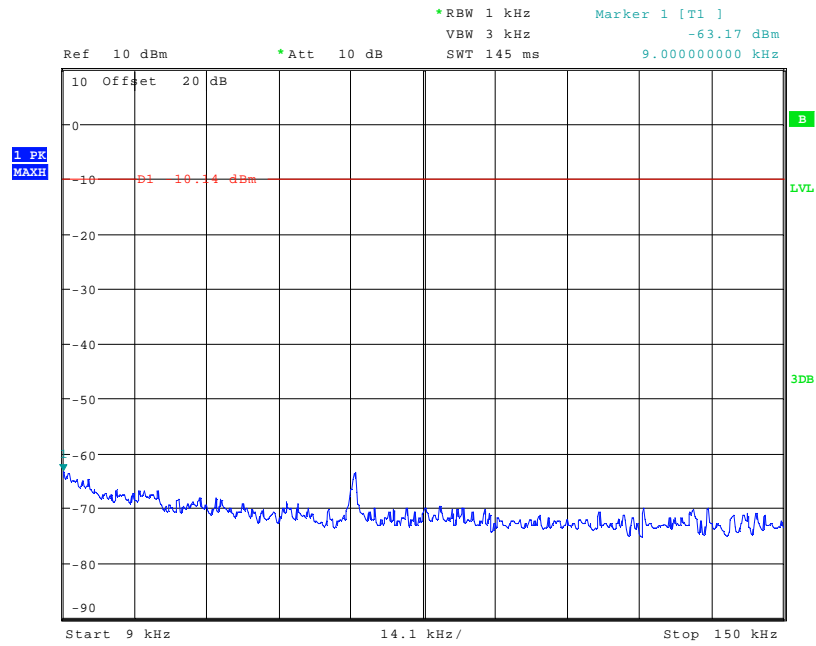
Date: 14.FEB.2012 14:04:24

### Conducted Spurious emissions 13 GHz to 19 GHz – 2435.0 MHz



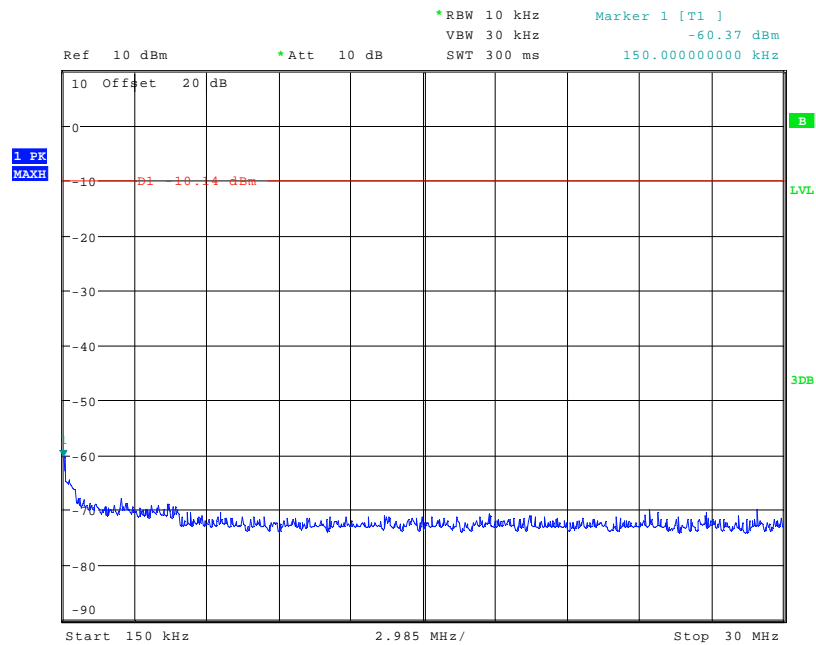
Date: 14.FEB.2012 14:04:41

Conducted Spurious emissions 19 GHz to 25 GHz – 2435.0 MHz



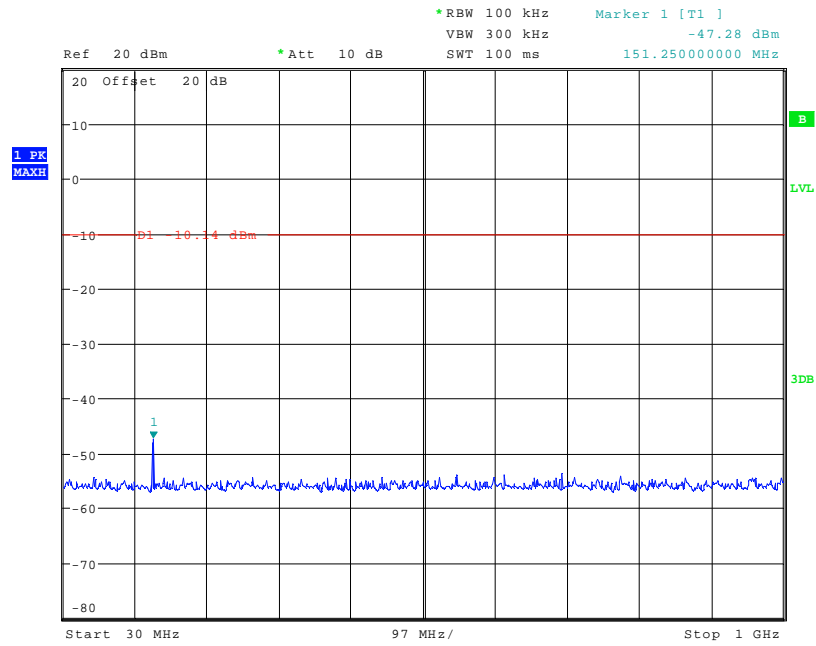
Date: 14.FEB.2012 14:15:34

### Conducted Spurious emissions 9kHz to 150 kHz – 2465.0 MHz



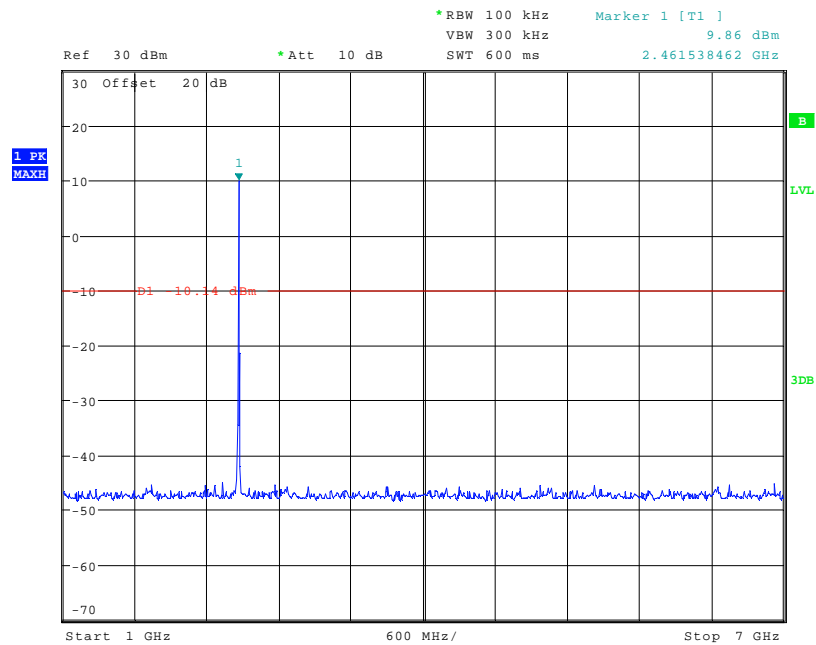
Date: 14.FEB.2012 14:16:47

### Conducted Spurious emissions 150kHz to 30 MHz – 2465.0 MHz



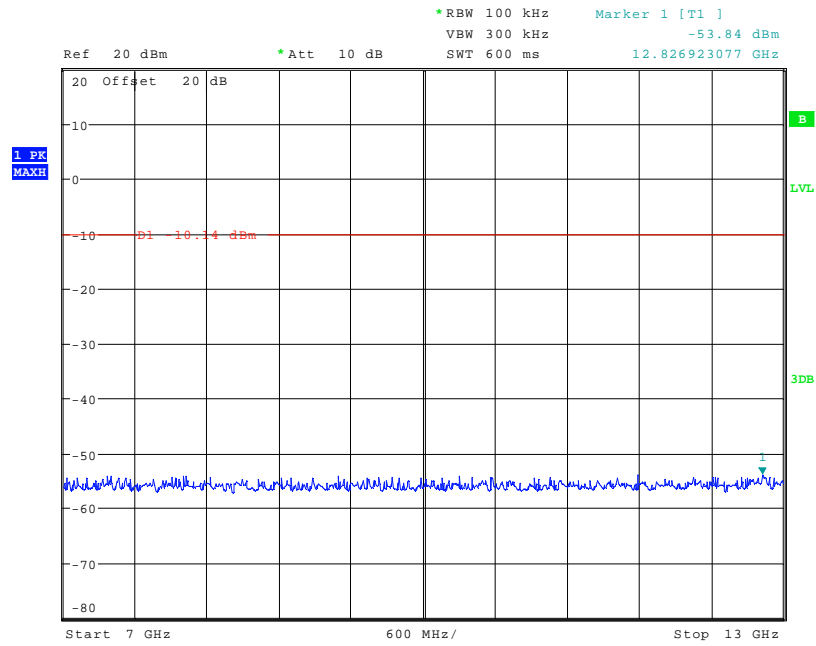
Date: 14.FEB.2012 14:17:28

### Conducted Spurious emissions 30 MHz to 1 GHz – 2465.0 MHz



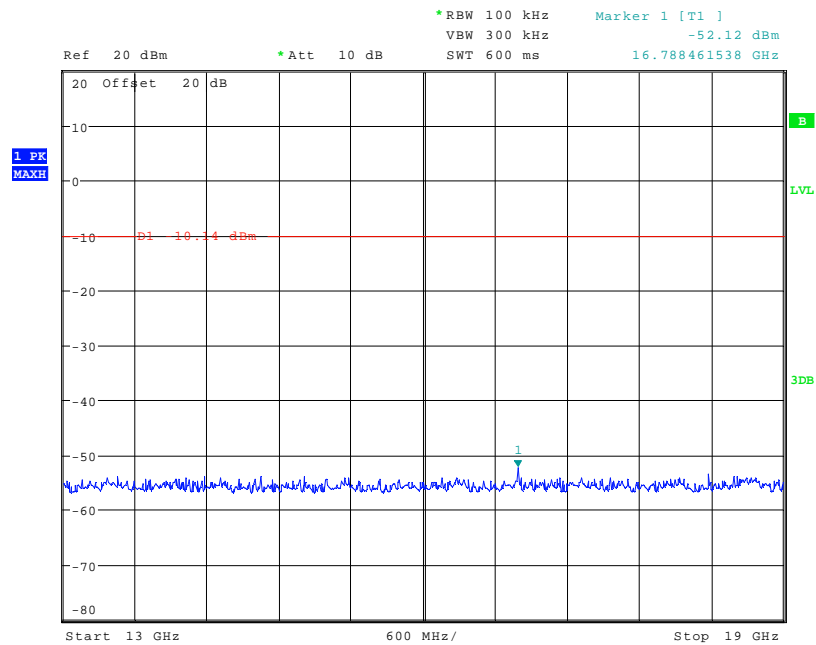
Date: 14.FEB.2012 14:14:58

### Conducted Spurious emissions 1 GHz to 7 GHz – 2465.0 MHz



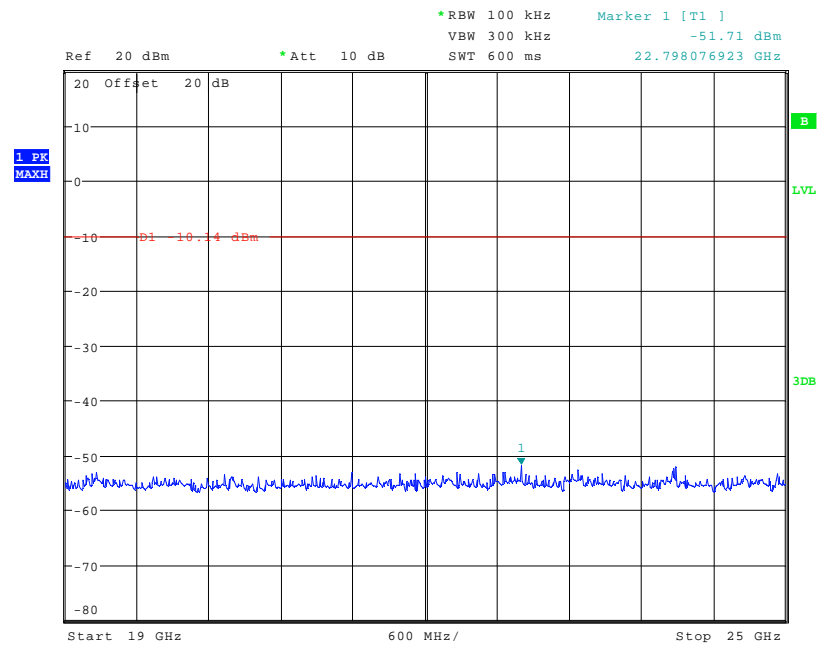
Date: 14.FEB.2012 14:17:51

### Conducted Spurious emissions 7 GHz to 13 GHz – 2465.0 MHz



Date: 14.FEB.2012 14:18:24

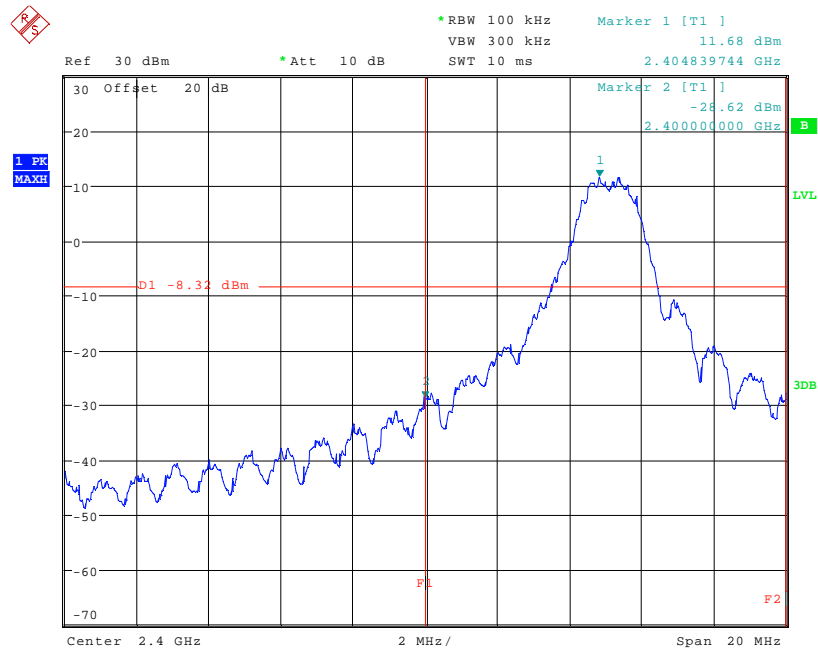
### Conducted Spurious emissions 13 GHz to 19 GHz – 2465.0 MHz



Date: 14.FEB.2012 14:18:45

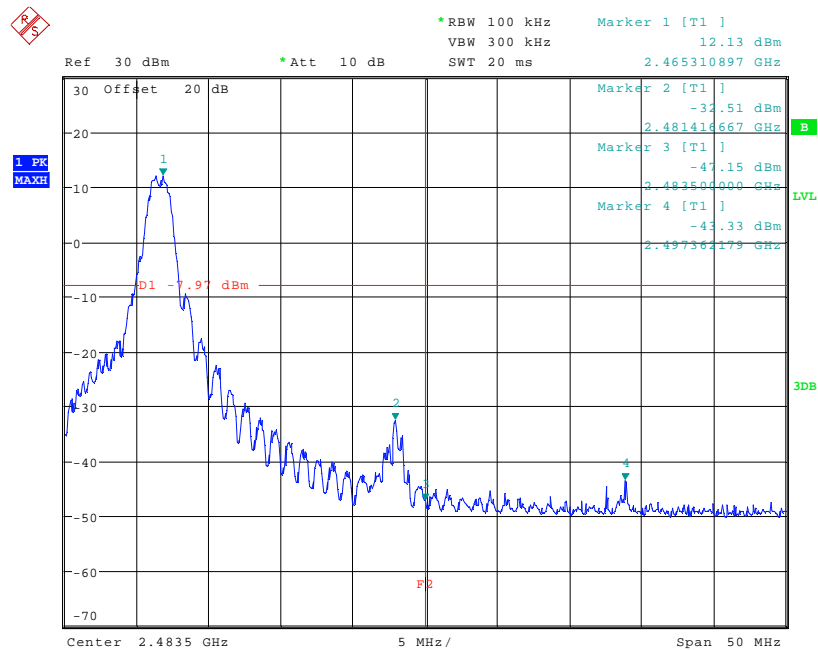
Conducted Spurious emissions 19 GHz to 25 GHz – 2465.0 MHz

## Conducted Bandedge Compliance



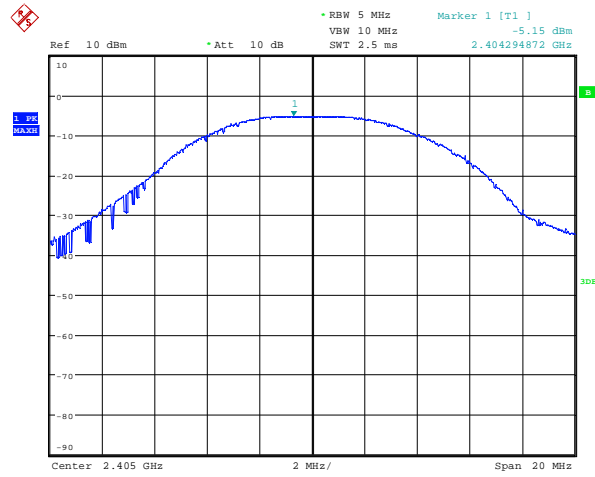
Date: 9.FEB.2012 14:58:08

## Lower Bandedge



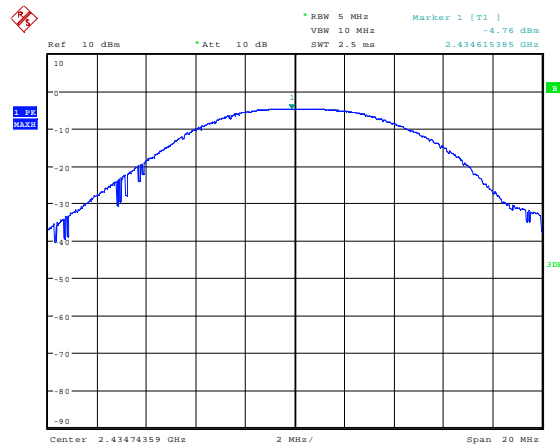
Date: 9.FEB.2012 14:35:47

## Upper Bandedge



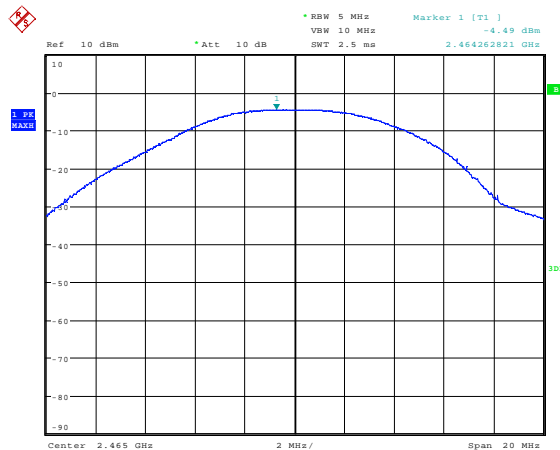
Date: 9.FEB.2012 12:54:23

Conducted carrier power 2405.0 MHz



Date: 9.FEB.2012 12:52:44

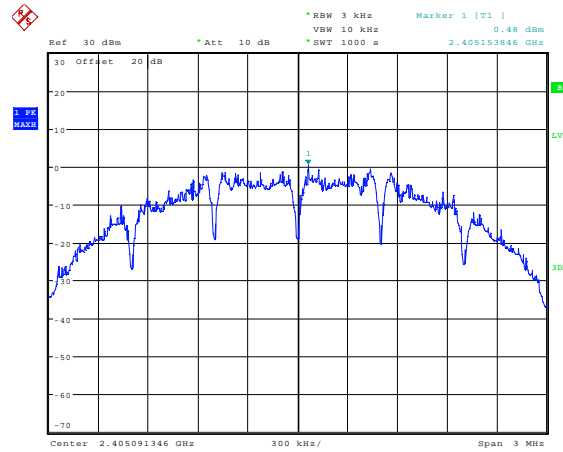
Conducted carrier power 2435.0 MHz



Date: 9.FEB.2012 12:51:20

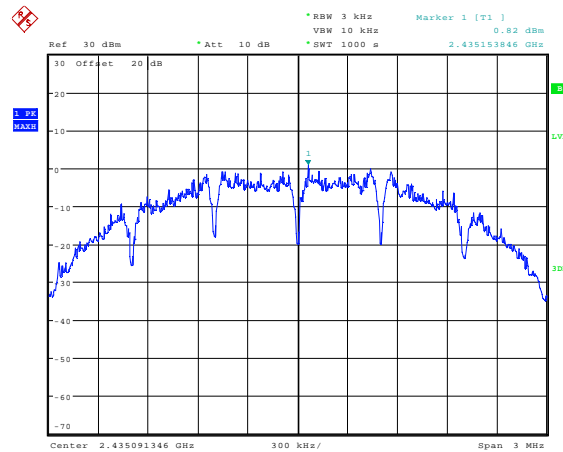
Conducted carrier power 2465.0 MHz





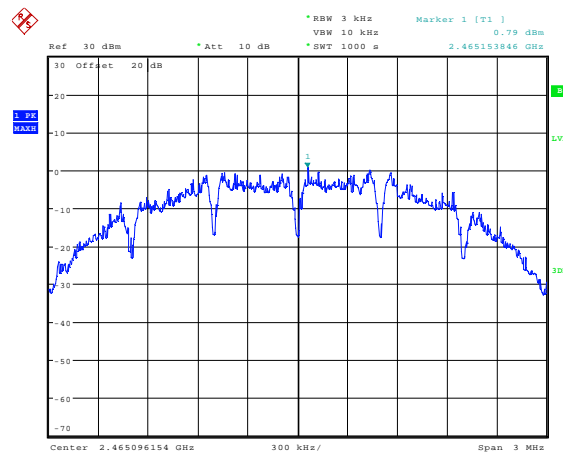
Date: 9.FEB.2012 13:18:55

### Conducted power spectral density 2405.0 MHz



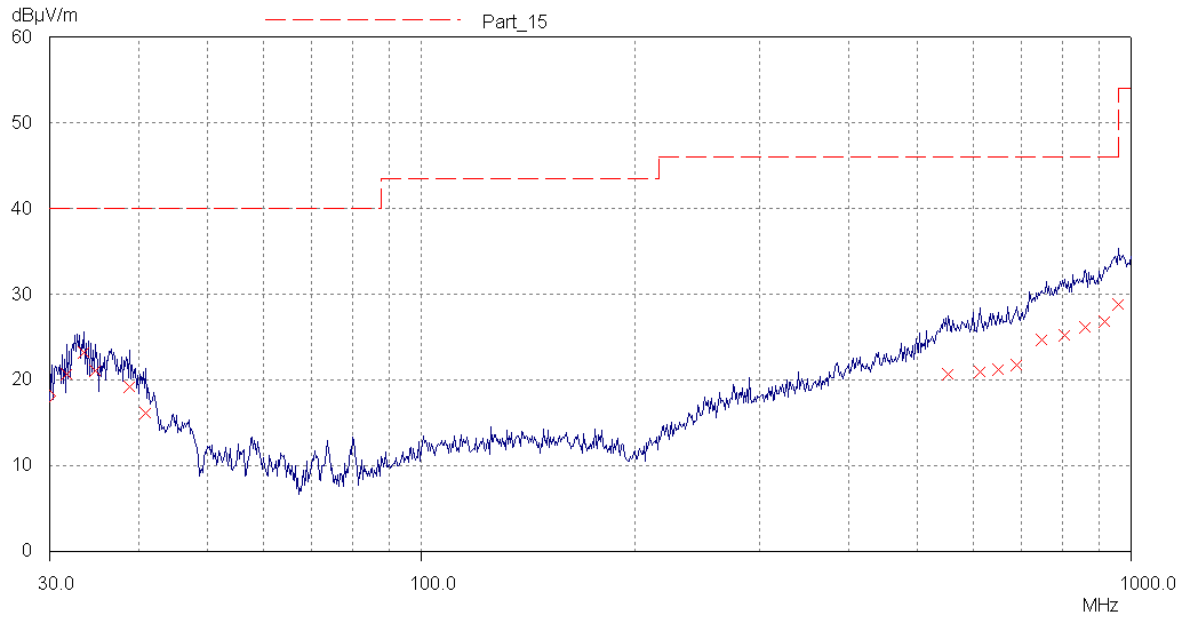
Date: 9.FEB.2012 13:43:12

### Conducted power spectral density 2435.0 MHz

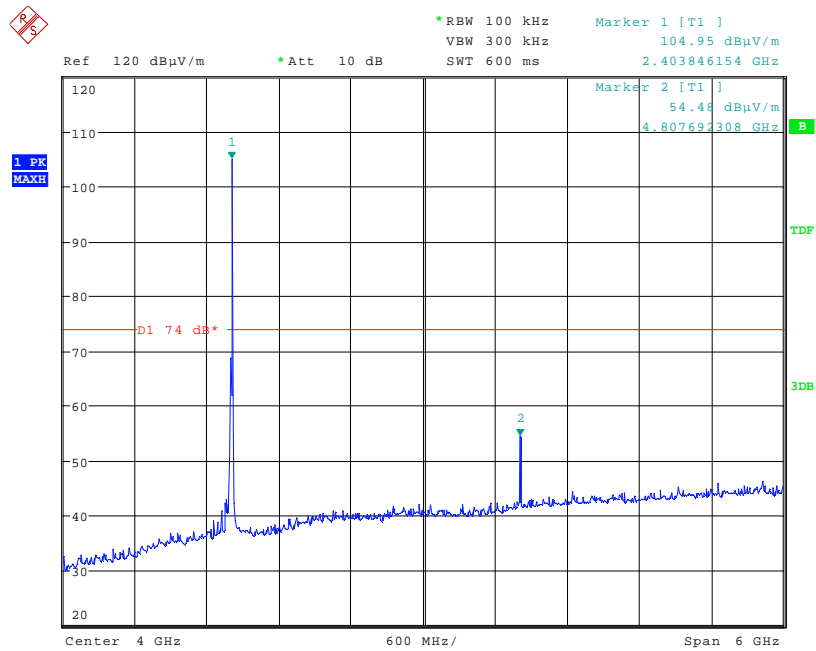


Date: 9.FEB.2012 14:04:12

### Conducted power spectral density 2465.0 MHz

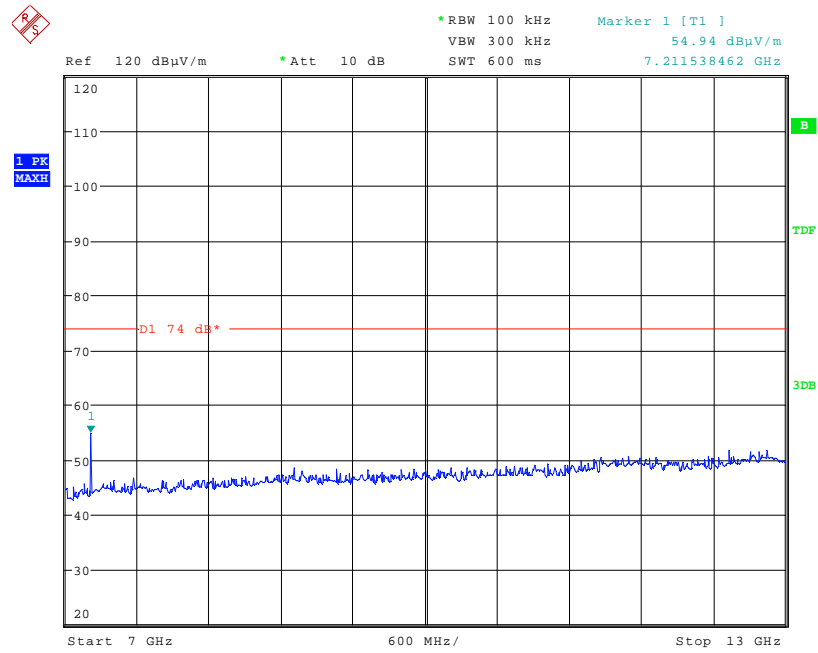


### Radiated Spurious emissions 30 MHz to 1 GHz – 2405.0 MHz



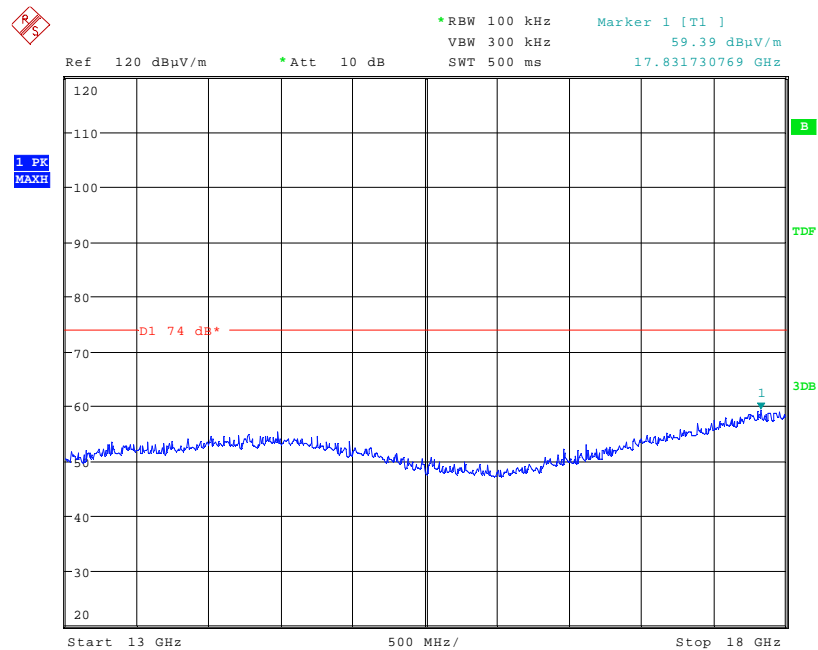
Date: 7.FEB.2012 15:06:38

### Radiated Spurious emissions 1 GHz to 7 GHz – 2405.0 MHz



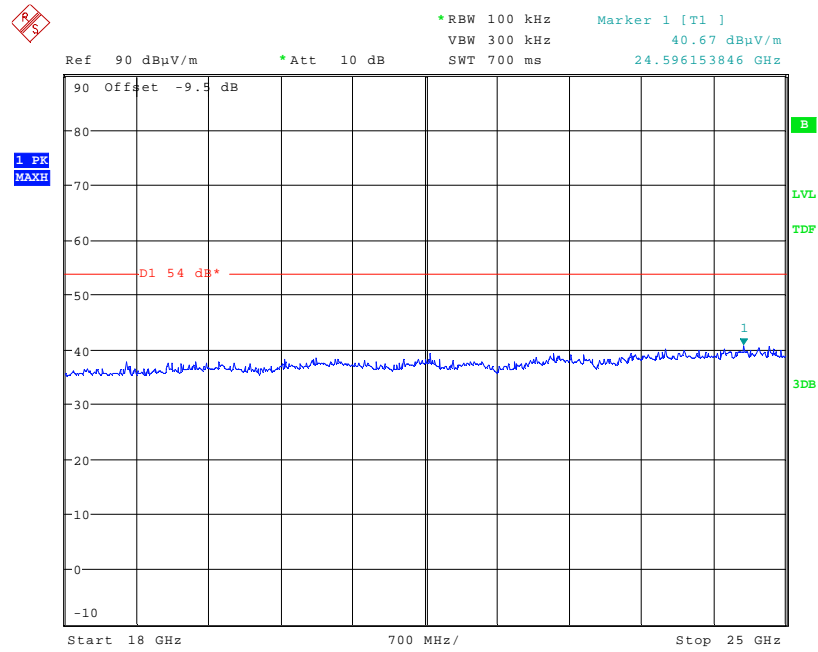
Date: 7.FEB.2012 15:07:20

### Radiated Spurious emissions 7 GHz to 13 GHz – 2405.0 MHz



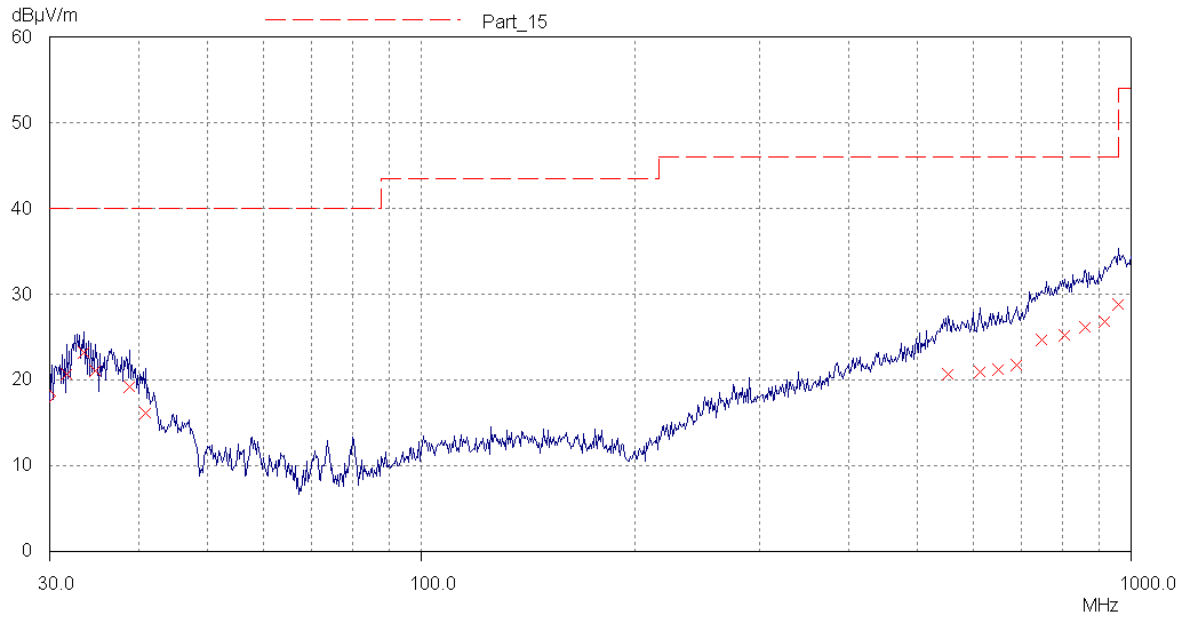
Date: 7.FEB.2012 15:07:49

### Radiated Spurious emissions 13 GHz to 18 GHz – 2405.0 MHz

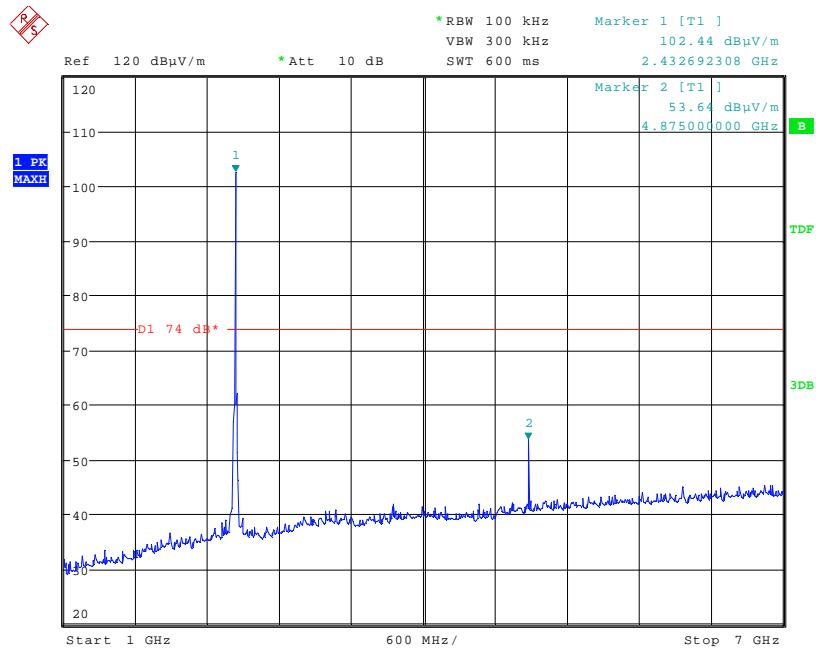


Date: 8.FEB.2012 16:43:03

Radiated Spurious emissions 18 GHz to 25 GHz – 2405.0 MHz

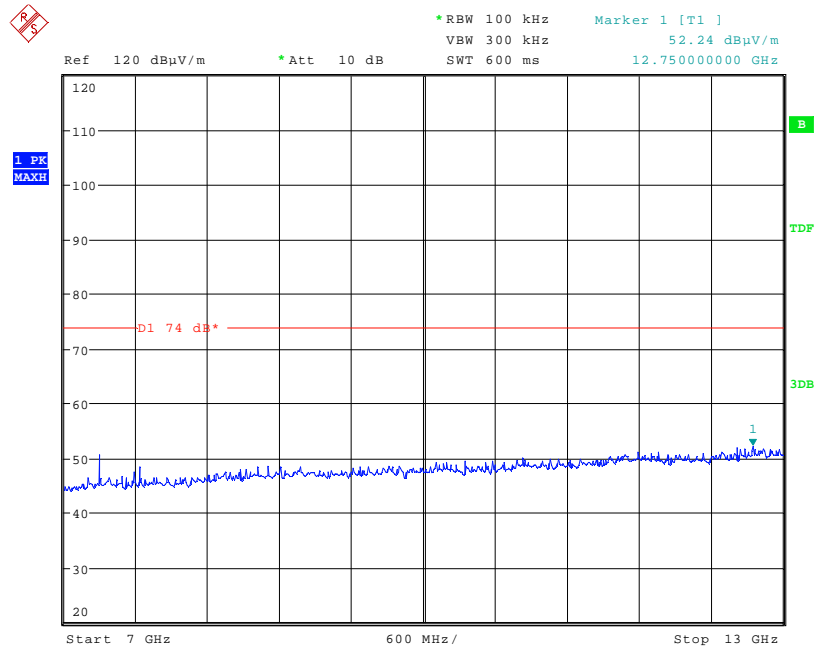


### Radiated Spurious emissions 30 MHz to 1 GHz – 2435.0 MHz



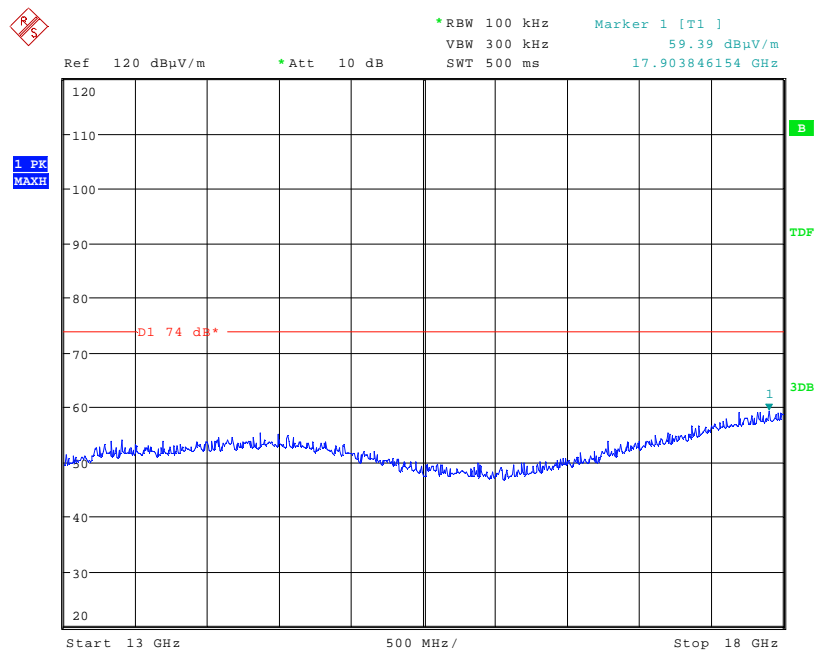
Date: 7.FEB.2012 15:01:25

### Radiated Spurious emissions 1 GHz to 7 GHz – 2435.0 MHz



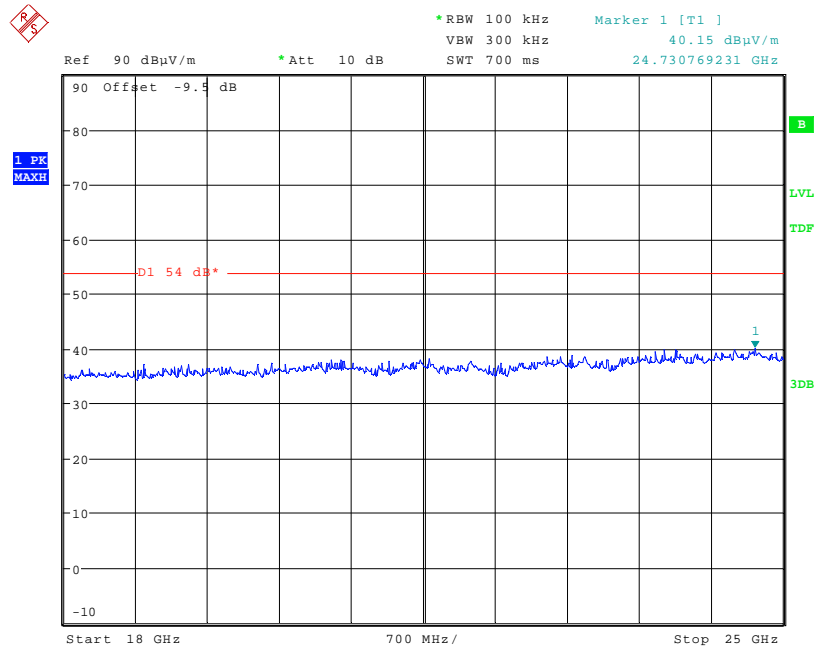
Date: 7.FEB.2012 15:00:50

### Radiated Spurious emissions 7 GHz to 13 GHz – 2435.0 MHz



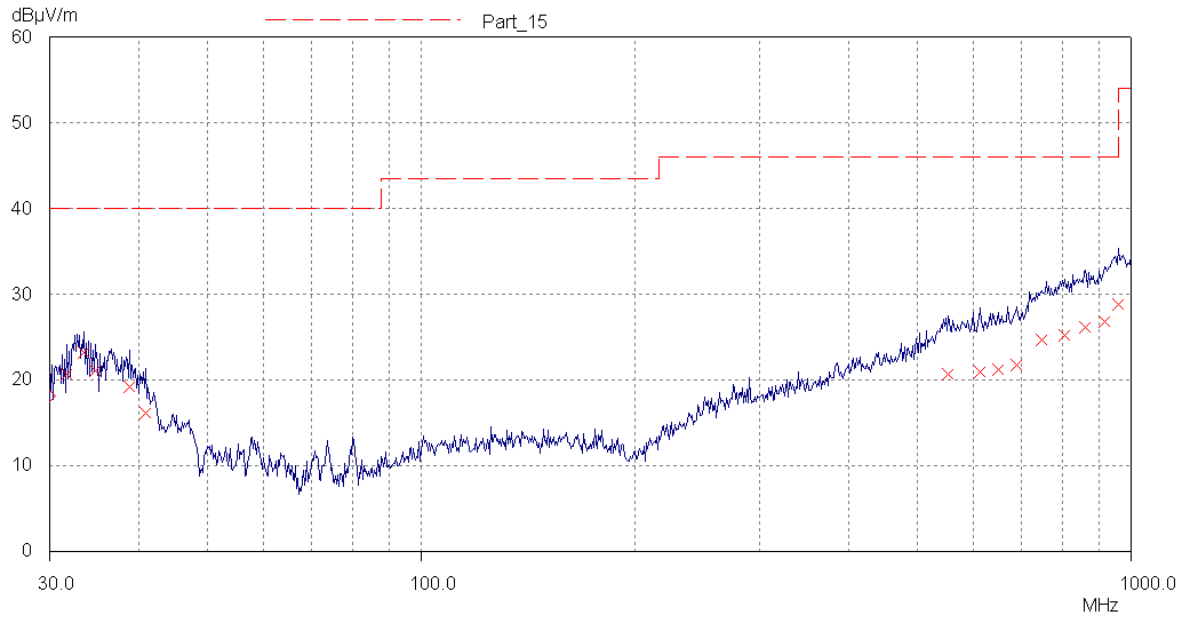
Date: 7.FEB.2012 14:59:07

### Radiated Spurious emissions 13 GHz to 18 GHz – 2435.0 MHz

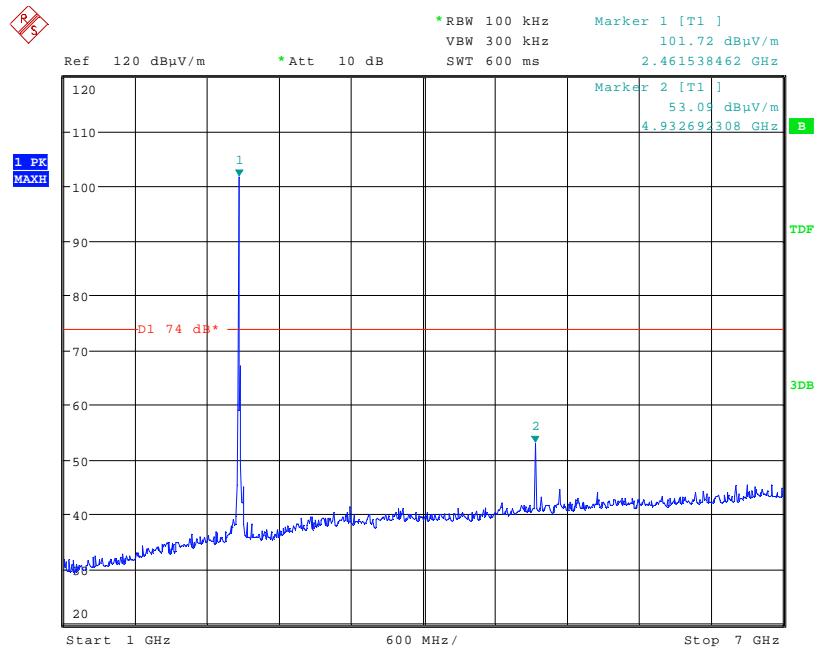


Date: 8.FEB.2012 16:48:37

Radiated Spurious emissions 18 GHz to 25 GHz – 2435.0 MHz



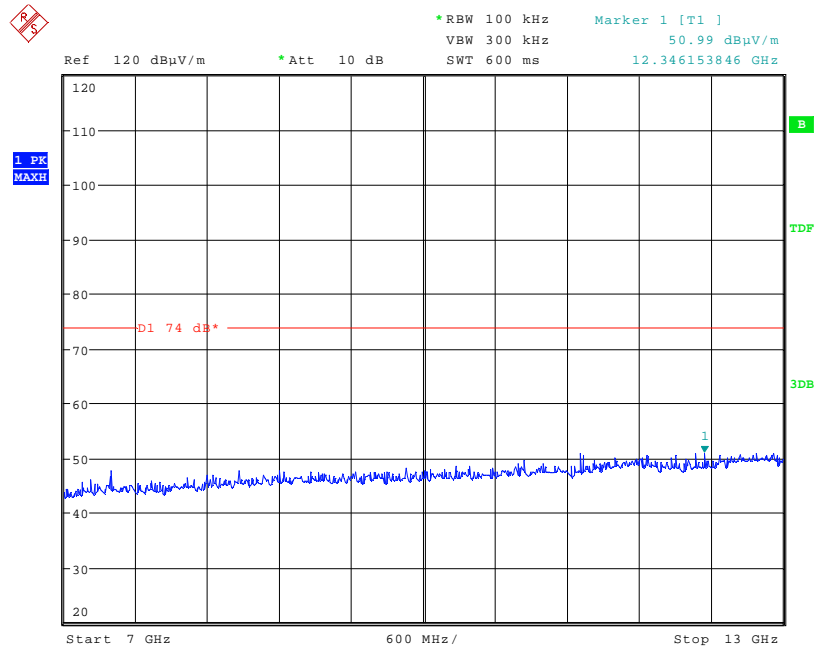
Radiated Spurious emissions 30 MHz to 1 GHz – 2465.0 MHz



Date: 7.FEB.2012 14:48:58

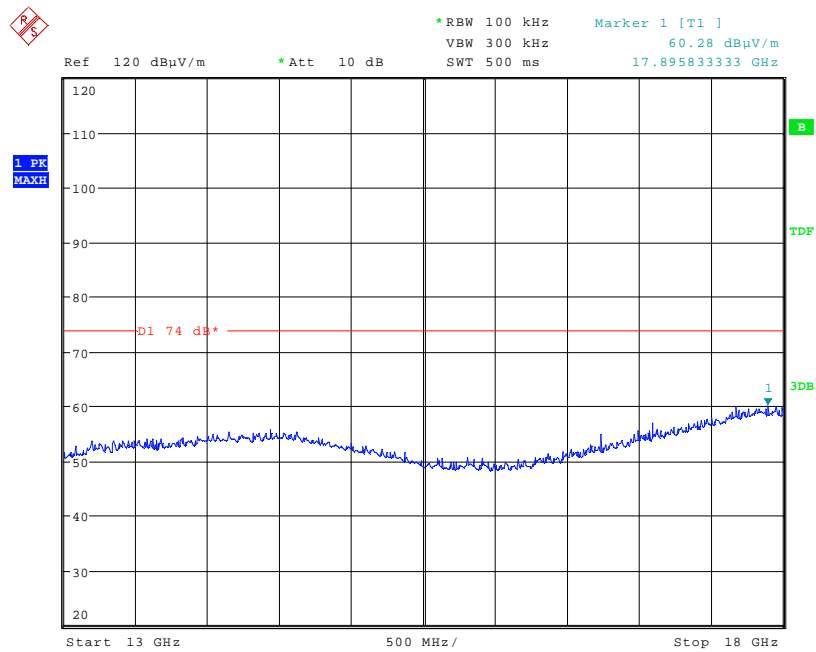
Radiated Spurious emissions 1 GHz to 7 GHz – 2465.0 MHz





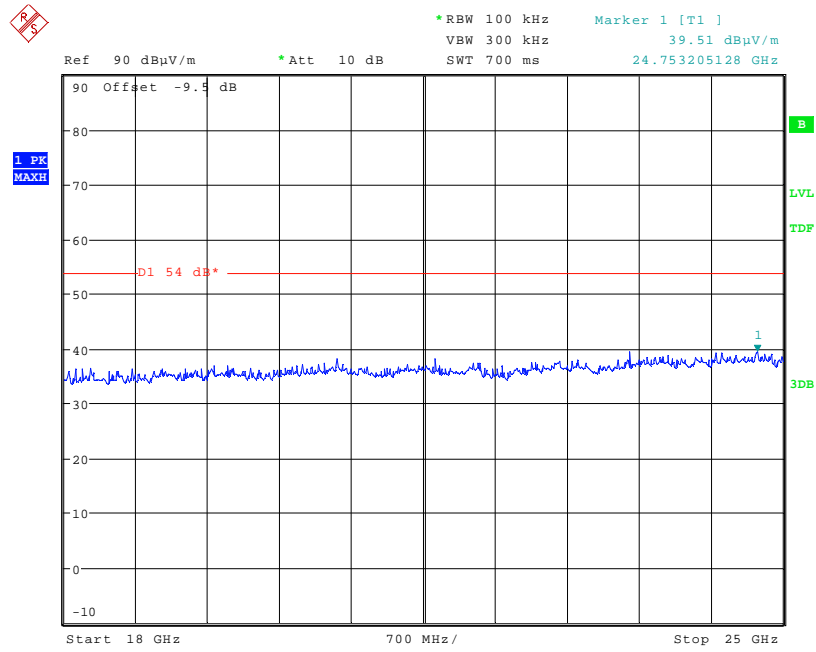
Date: 7.FEB.2012 14:48:32

### Radiated Spurious emissions 7 GHz to 13 GHz – 2465.0 MHz



Date: 7.FEB.2012 14:48:02

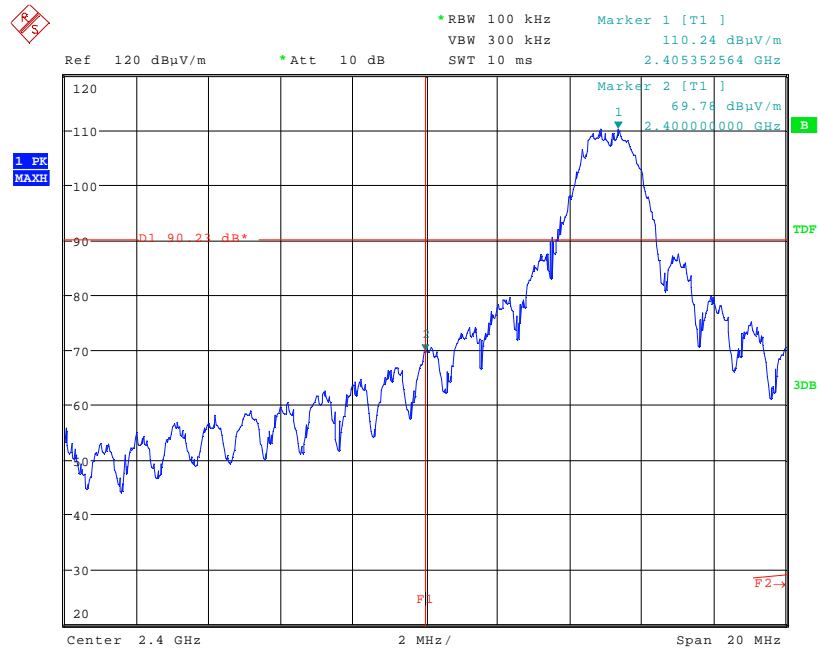
### Radiated Spurious emissions 13 GHz to 18 GHz – 2465.0 MHz



Date: 8.FEB.2012 16:50:06

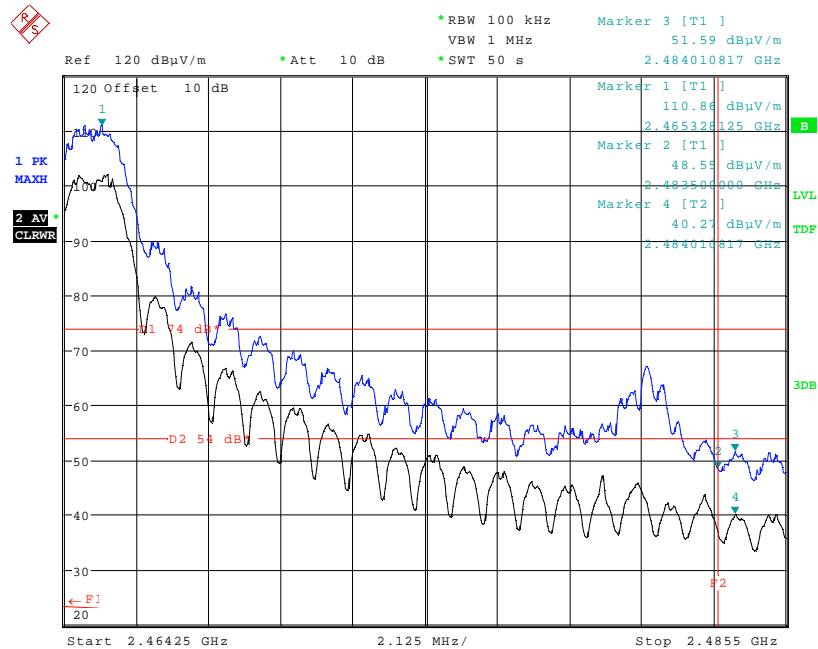
Radiated Spurious emissions 18 GHz to 25 GHz – 2465.0 MHz

## Radiated Bandedge Compliance



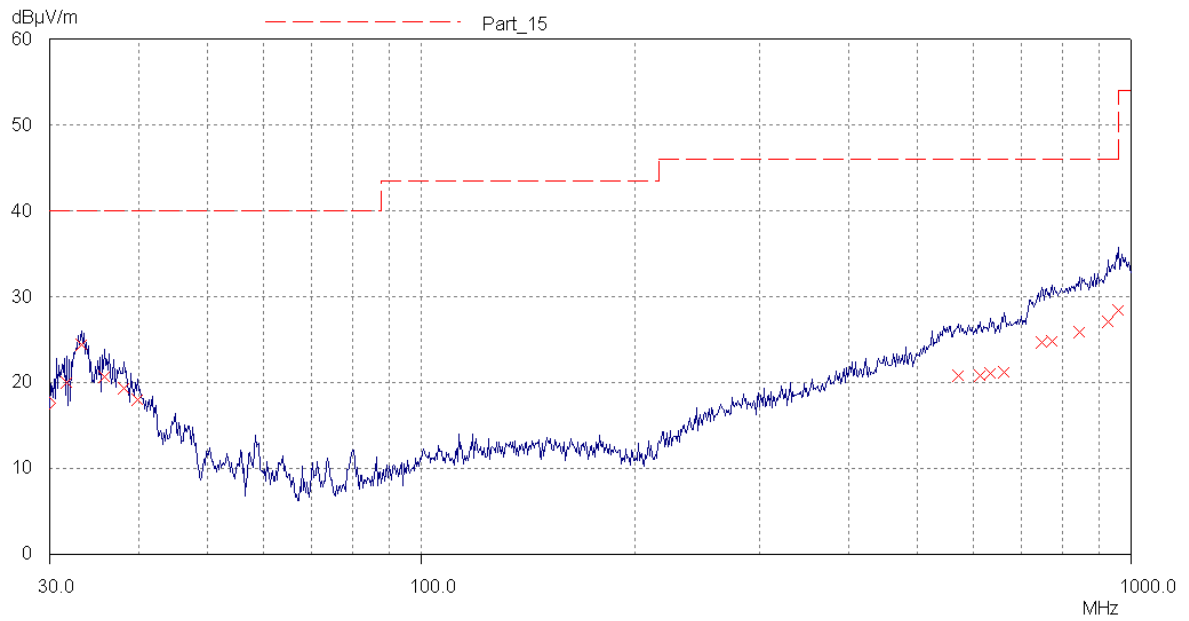
Date: 10.FEB.2012 15:01:24

## Lower Bandedge

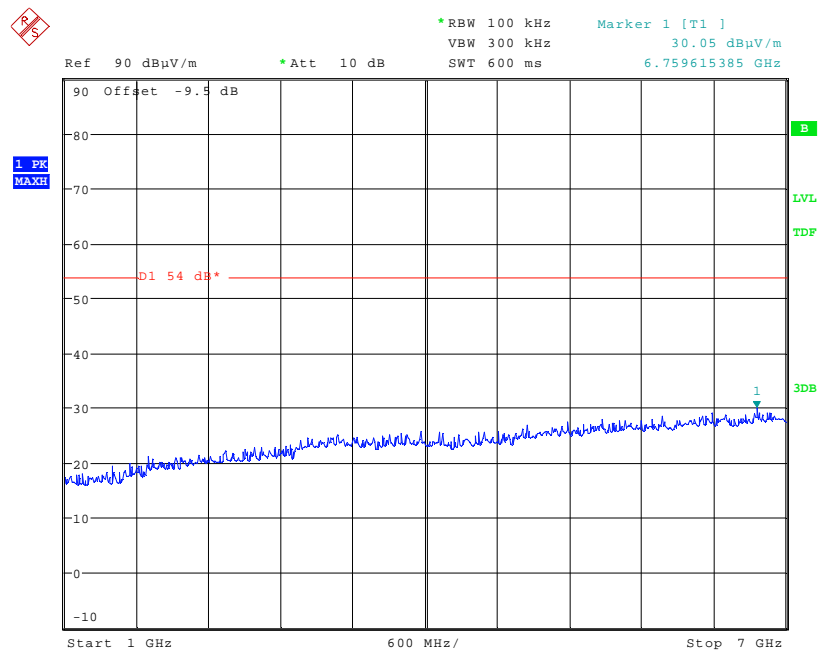


Date: 10.FEB.2012 15:49:30

## Upper Bandedge

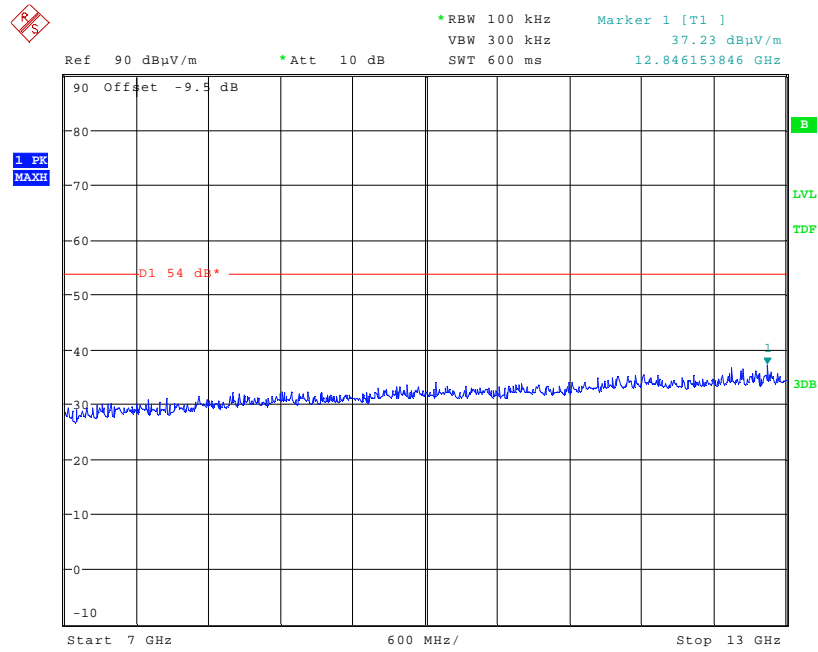


Unintentional Radiated Spurious emissions 30 MHz to 1 GHz – 2405.0 MHz



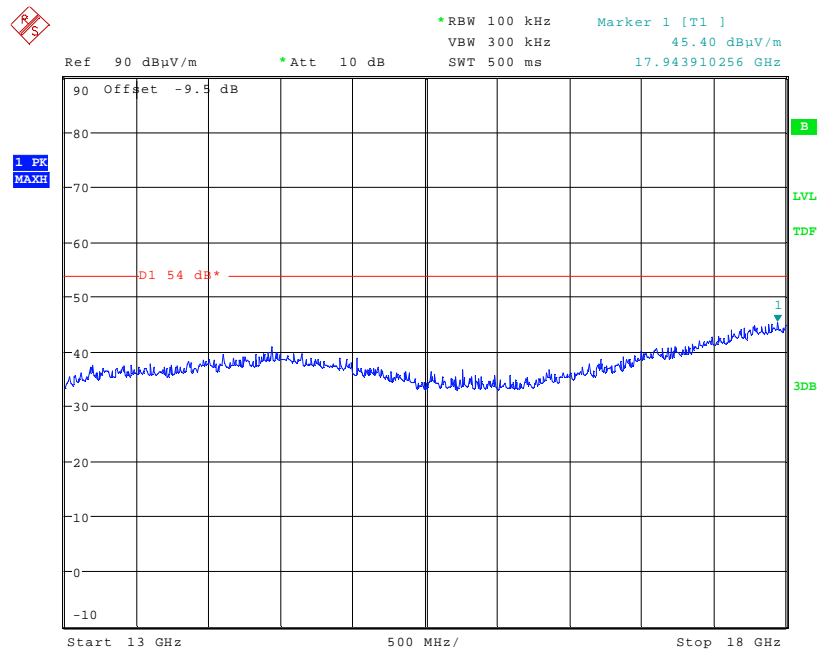
Date: 8.FEB.2012 16:02:07

Unintentional Radiated Spurious emissions 1 GHz to 7 GHz – 2405.0 MHz



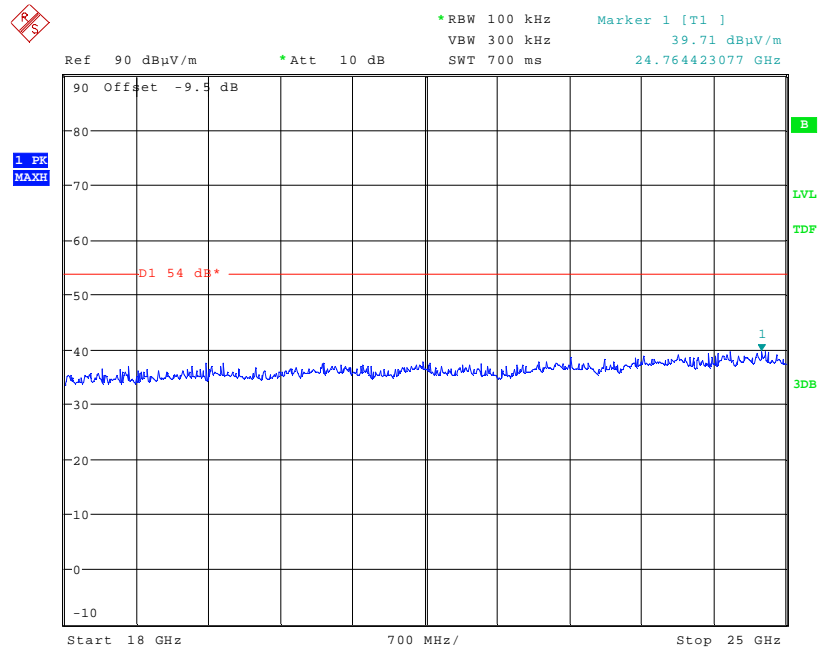
Date: 8.FEB.2012 16:24:45

### Unintentional Radiated Spurious emissions 7 GHz to 13 GHz – 2405.0 MHz



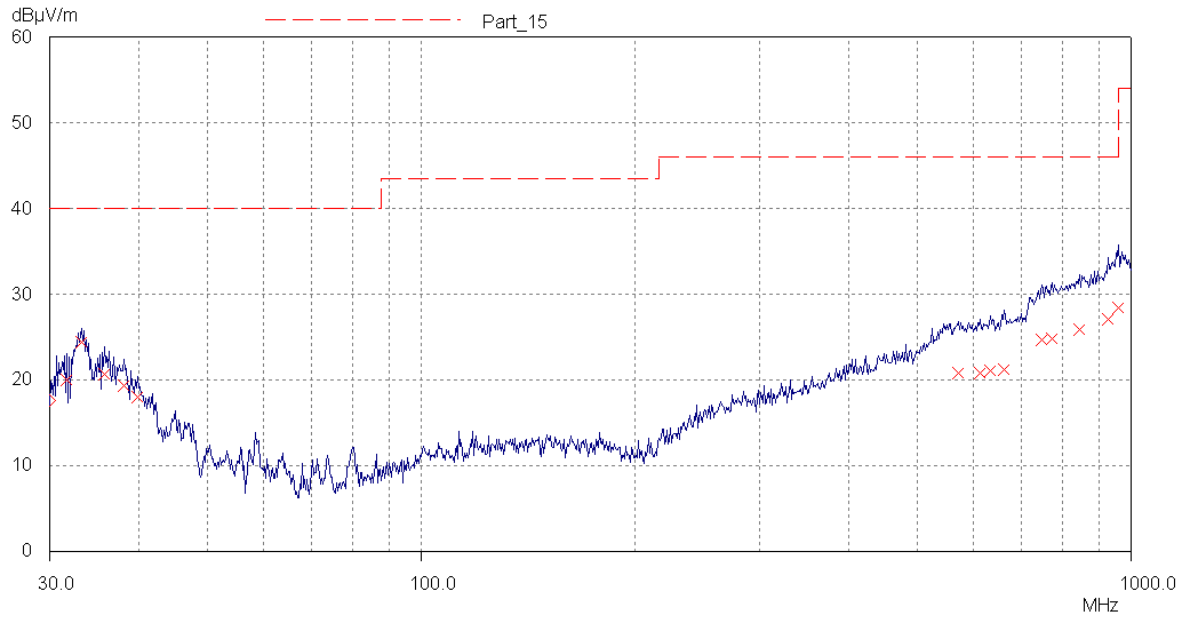
Date: 8.FEB.2012 16:24:28

### Unintentional Radiated Spurious emissions 13 GHz to 18 GHz – 2405.0 MHz

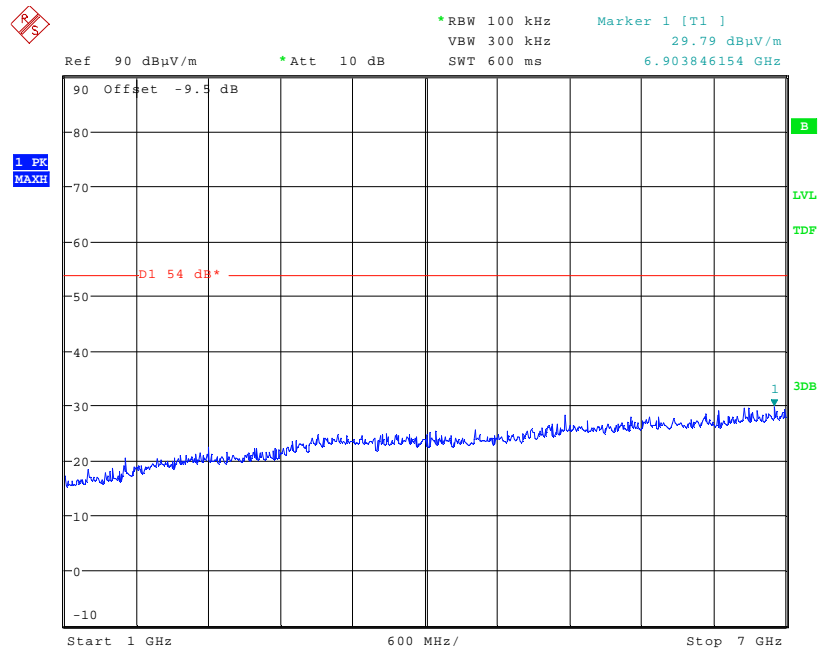


Date: 8.FEB.2012 16:34:40

Unintentional Radiated Spurious emissions 18 GHz to 25 GHz – 2405.0 MHz

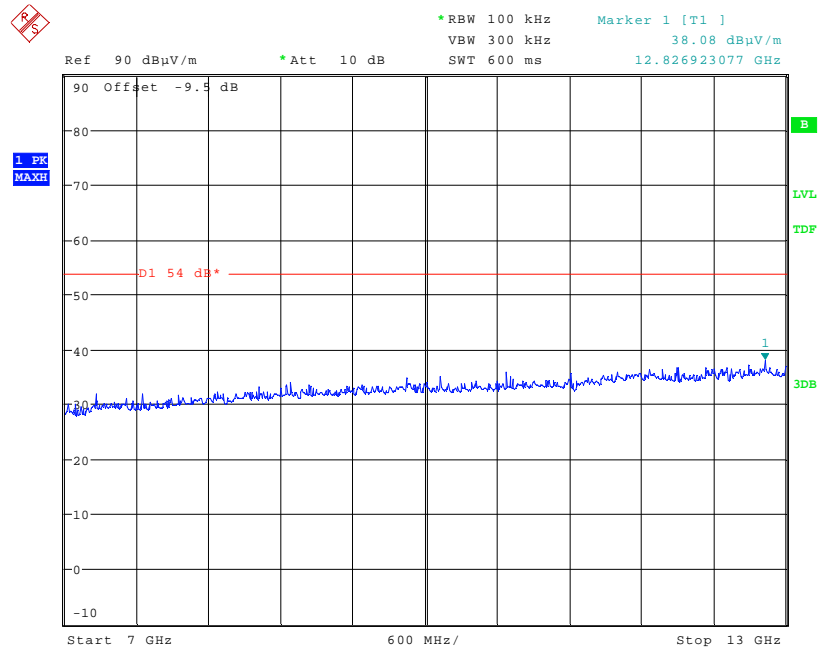


Unintentional Radiated Spurious emissions 30 MHz to 1 GHz – 2435.0 MHz



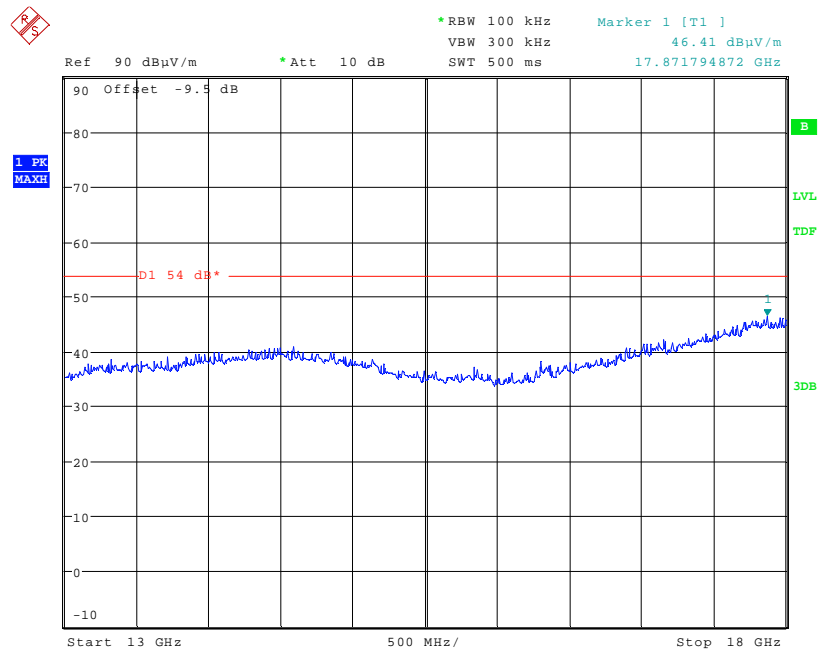
Date: 8.FEB.2012 16:16:45

Unintentional Radiated Spurious emissions 1 GHz to 7 GHz – 2435.0 MHz



Date: 8.FEB.2012 16:16:28

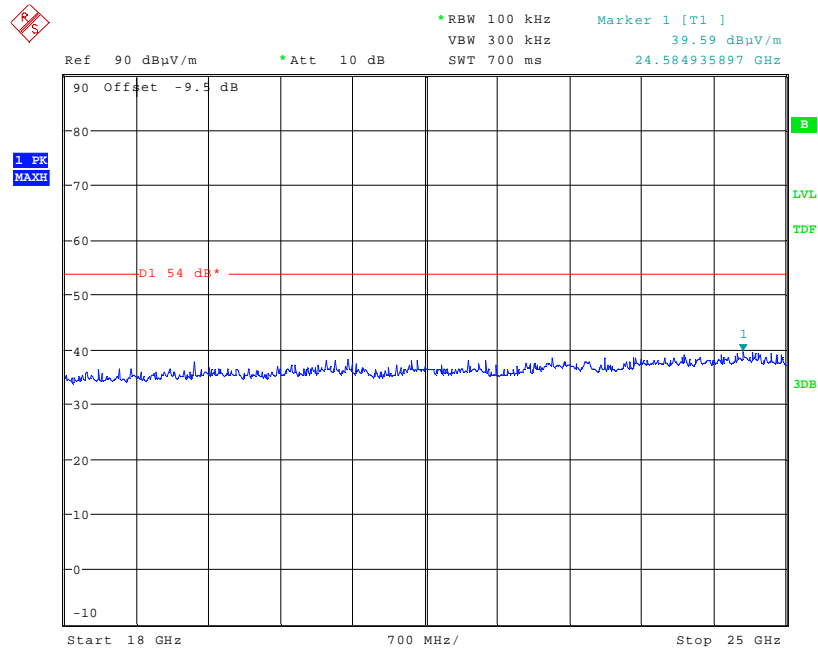
### Unintentional Radiated Spurious emissions 7 GHz to 13 GHz – 2435.0 MHz



Date: 8.FEB.2012 16:15:30

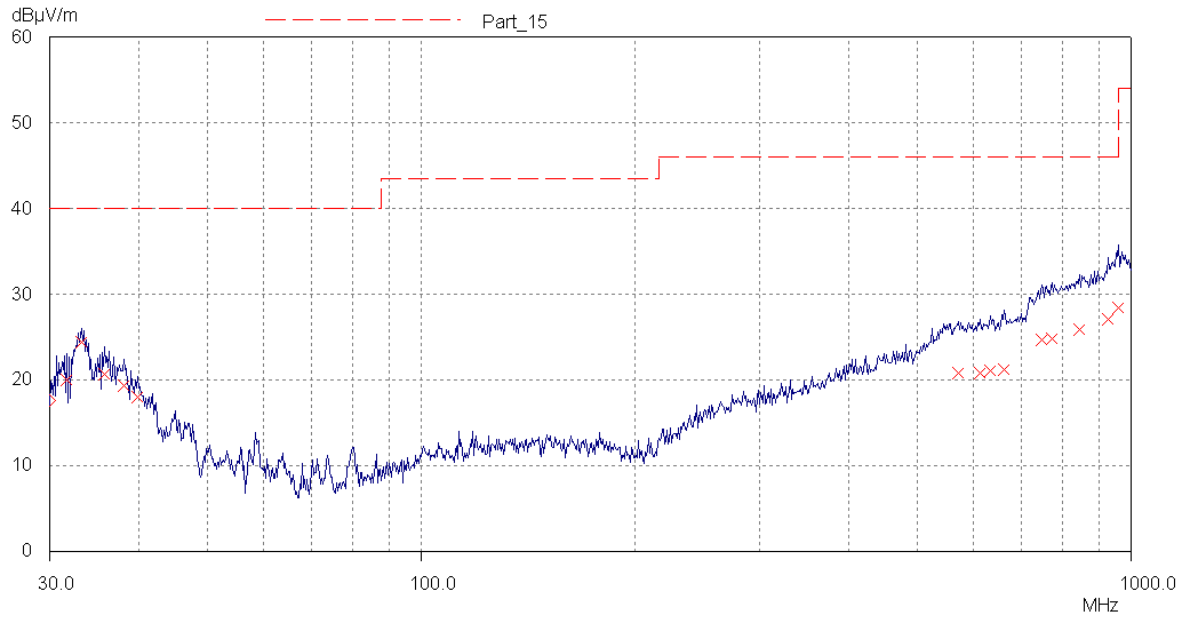
### Unintentional Radiated Spurious emissions 13 GHz to 18 GHz – 2435.0 MHz



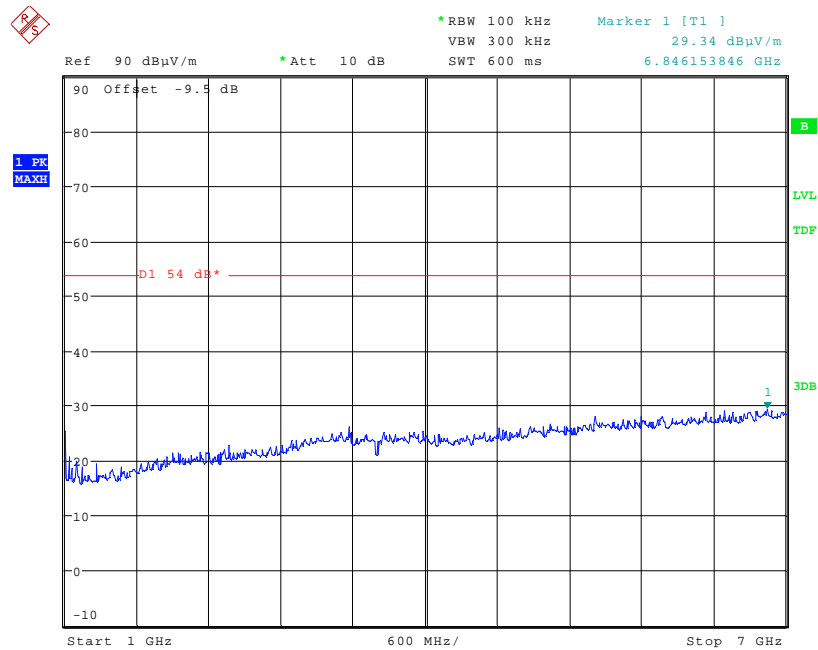


Date: 8.FEB.2012 16:33:50

Unintentional Radiated Spurious emissions 18 GHz to 25 GHz – 2435.0 MHz

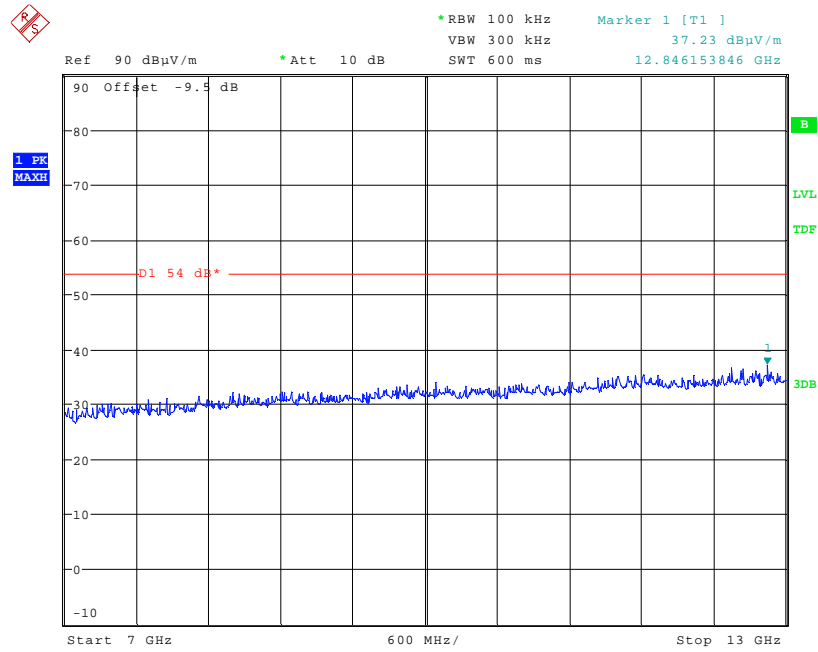


### Unintentional Radiated Spurious emissions 30 MHz to 1 GHz – 2465.0 MHz



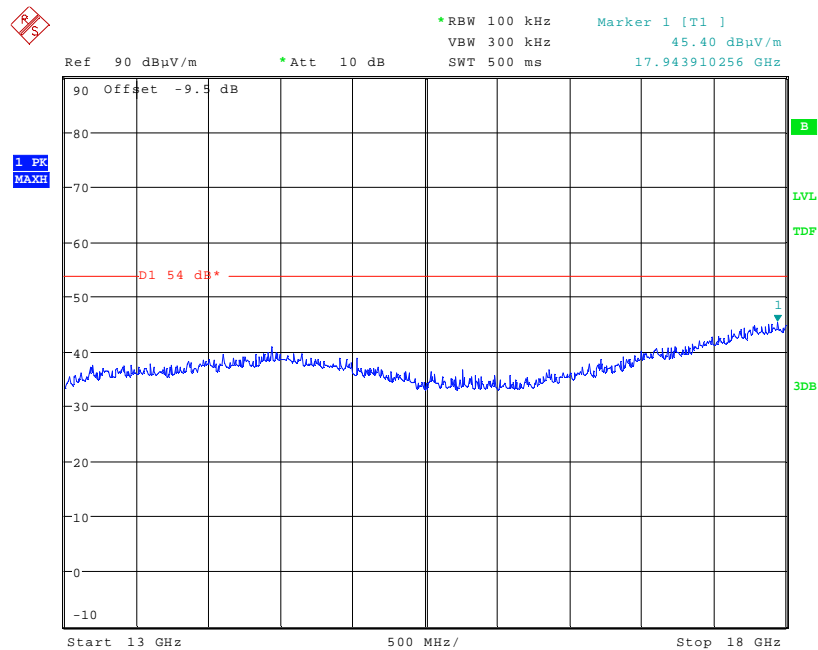
Date: 8.FEB.2012 16:25:11

### Unintentional Radiated Spurious emissions 1 GHz to 7 GHz – 2465.0 MHz



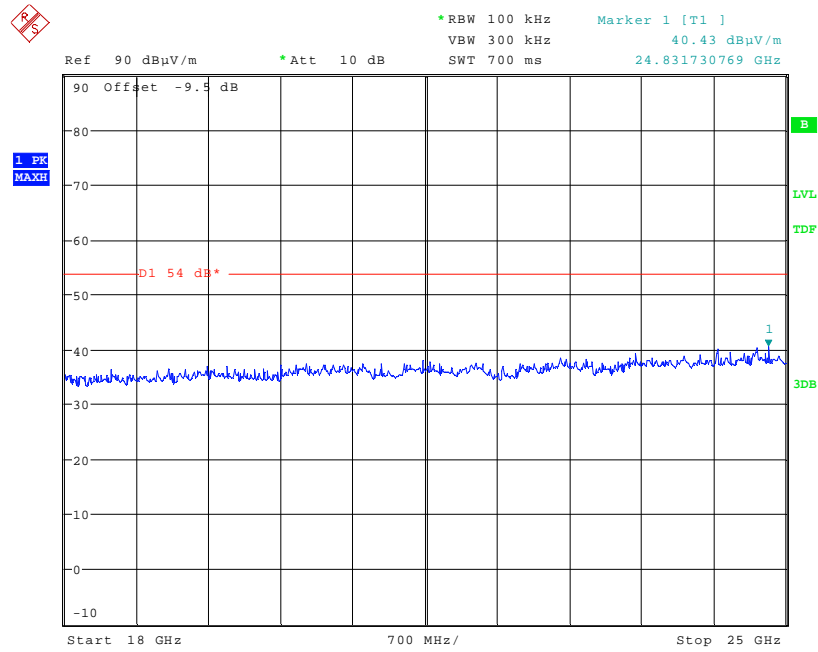
Date: 8.FEB.2012 16:24:45

### Unintentional Radiated Spurious emissions 7 GHz to 13 GHz – 2465.0 MHz



Date: 8.FEB.2012 16:24:28

### Unintentional Radiated Spurious emissions 13 GHz to 18 GHz – 2465.0 MHz



Date: 8.FEB.2012 16:30:51

Unintentional Radiated Spurious emissions 18 GHz to 25 GHz – 2465.0 MHz

**Appendix C:****Additional Test and Sample Details**

This appendix contains details of:

1. The samples submitted for testing.
2. Details of EUT operating mode(s)
3. Details of EUT configuration(s) (see below).
4. EUT arrangement (see below).

Throughout testing, the following numbering system is used to identify the sample and it's modification state:

**Sample No:** Sxx Mod w

where:

xx	= sample number	eg. S01
w	= modification number	eg. Mod 2

The following terminology is used throughout the test report:

**Support Equipment (SE)** is any additional equipment required to exercise the EUT in the applicable operating mode. Where relevant SE is divided into two categories:

SE in test environment: The SE is positioned in the test environment and is not isolated from the EUT (e.g. on the table top during REFE testing).

SE isolated from the EUT: The SE is isolated via filtering from the EUT. (e.g. equipment placed externally to the ALSR during REFE testing).

**EUT configuration** refers to the internal set-up of the EUT. It may include for example:

- Positioning of cards in a chassis.
- Setting of any internal switches.
- Circuit board jumper settings.
- Alternative internal power supplies.

Where no change in EUT configuration is **possible**, the configuration is described as "single possible configuration".

**EUT arrangement** refers to the termination of EUT ports / connection of support equipment, and where relevant, the relative positioning of samples (EUT and SE) in the test environment.

For further details of the test procedures and general test set ups used during testing please refer to the related document "EMC Test Methods - An Overview", which can be supplied by TRaC Global upon request.

**C1) Test samples**

The following samples of the apparatus were submitted by the client for testing :

Sample No.	Description	Identification
S01	RF Module	
S02	Antenna	

The following samples of apparatus were submitted by the client as host, support or drive equipment (auxiliary equipment):

Sample No.	Description	Identification
None		

The following samples of apparatus were supplied by TRaC Global as support or drive equipment (auxiliary equipment):

Identification	Description
TRLUH100	PSU

**C2) EUT Operating Mode During Testing.**

During testing, the EUT was exercised as described in the following tables:

Test	Description of Operating Mode:
All Transmitter tests detailed in this report	EUT active and transmitting on the required channel. The EUT was Powered via a PSU located remotely from the device. Antenna Connected. There were no other connections made Test mode initialised Via PC (PC removed during testing)

Test	Description of Operating Mode:
Unintentional radiated spurious emissions	EUT active but non-transmitting on the required channel. The EUT was Powered via a PSU located remotely from the device. Antenna Connected. There were no other connections made Test mode initialised Via PC (PC removed during testing)

**C3) EUT Configuration Information.**

The EUT was submitted for testing in one single possible configuration.



**C4) List of EUT Ports**

The tables below describe the termination of EUT ports:

Sample : S01  
Tests : Conducted

Port	Description of Cable Attached	Cable length	Equipment Connected
Power	2 wire	1m	PSU
Antenna	Coaxial Cable	<1m	Measurement System
SK4 (Serial USB)	3 wire	2m	Laptop*

Sample : S01  
Tests : Radiated Emissions

Port	Description of Cable Attached	Cable length	Equipment Connected
Power	2 wire	1m	PSU
Antenna	Coaxial Cable	10cm	S02 (antenna)
SK4 (Serial USB)	3 wire	2m	Laptop*

\* Only connected during setup.

**C5 Details of Equipment Used**

TRAC Ref	Type	Description	Manufacturer	Date Calibrated.
REF909	FSU26	Spectrum Analyser	Rhode & Schwarz	04/08/2011
TRL138	3115	1-18GHz Horn Antenna	EMCO	08/11/2011
TRL572	8499B	1 – 26.5 GHz Pre Amplifier	Agilent	24/11/2010
TRL317	ESHS10	Receiver	Rhode & Schwarz	21/12/2011
TRLUH191	CBL611/A	BiLog Periodic Antenna	York	08/11/2010

For Conducted Measurements

TRAC Ref	Type	Description	Manufacturer	Date Calibrated.
REF909	FSU26	Spectrum Analyser	Rhode & Schwarz	04/08/2011
None	10 dB	Attenuator (x2)	N/A	Cal In use

## Appendix D:

## Additional Information

Daniel Winstanley

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**From:** Harris, Mark [Mark.Harris@rotork.com]  
**Sent:** 09 February 2012 11:55  
**To:** Daniel Winstanley  
**Cc:** John Charters; Steven Hodgkinson; Sandeep Bharat  
**Subject:** RE: RF testing  
**Attachments:** 1044-11-EE-11-PB002\_Entwurf.pdf

Hi Daniel,  
 Thanks for that.

Below is a copy of the text from an Atmel report where the duty cycle is measured. This report is for different hardware, but under control of the same software, which is what controls the duty cycle.

I have also attached the report. The relevant page is 26.

Based on this, we declare that the duty cycle is 8.4%.

Note that the measured figure is 8.4%, not the 8.2% used in the Atmel report for the module we are using.

I don't think this makes much of a difference, but I think we should use 8.4%, as we have evidence to back this up.

Thanks and regards,  
 Mark.

**Channel**

[Kanal]

**Periodic phenomenon**

[periodische Erscheinung]

**Measuring values**

[Messwerte]

11 (2,405 GHz) Burst duration

[Burst Dauer] 4.2 ms

Burst period

[Burst Periode] 51.8 ms

Duty cycle (over 100 ms)

[Tastgrad (über 100 ms)] 8.4 %

**Table 8:** Measuring values (conducted) at 250 kbps [Messwerte (leitungsführt) bei 250 kbps]

**Evaluation**

[Bewertung]

The maximum duty cycle is less than 10 % over 100 ms

[Der maximale Tastgrad ist innerhalb von 100 ms kleiner als 10 %]

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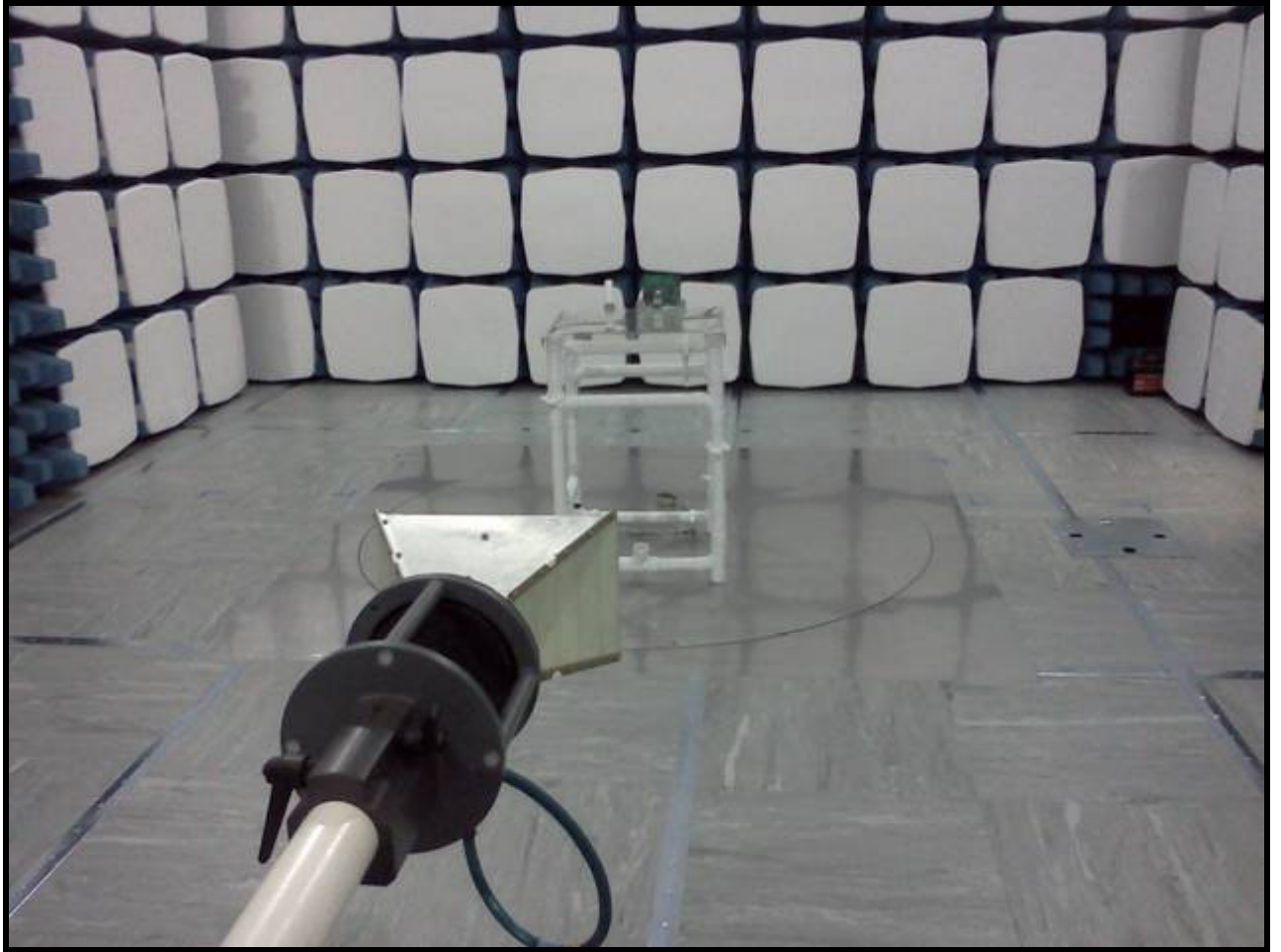
14/02/2012

## **Appendix E:**

## **Photographs and Figures**

The following photographs were taken of the test samples:

1. Radiated electric field emissions arrangement: Pakscan 3 Wireless Field Control Unit front view.
2. Radiated electric field emissions arrangement: Pakscan 3 Wireless Field Control Unit close up.



Photograph 1



Photograph 2

